THE WORLD IS ITS FIELD.

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RUSSIA AS A MARKET FOR MACHINERY AND MACHINE TOOLS.

By A. H. Ford.

This fourth paper by Mr. Ford concludes the series of which the earlier numbers appeared in our issues for February, March, and April of this year. Its unavoidable postponement has been turned to an actual advantage, in that Mr. Ford is thereby enabled to analyze accurately the results of the Russo-American tariff conflict. He believes that the volume of American manufactures finding their way to Russia will not be greatly diminished. But even this comparatively favorable conclusion will be far from wholly gratifying to the United States exporter, when it is noted that the volume will be maintained only by adopting indirect and underground trade routes, playing largely in the ultimate into the hands of Britain and Germany. The logic of the situation can be met eventually only by such a revision of the outworn tariff system of the United States as Mr. Saunders ably argued in our April number.—THE EDITORS.

DIRECT effects of the recent fifty per cent. increase of duties on American machinery entering Russia have been actively debated. Therefore, it may be a source of consolation to the United States, if not to their European competitors, to learn that the largest shipment of machinery ever sent to any part of the world left New York city in March, after the DeWitte-Gage tiff—for Russia.

Russia is not given to cutting off her nose to spite her face. Machinery needed for state railways, or agricultural machinery, which the peasants must have, will not be subjected to the additional arbitrary tax; and as for machinery and tools for the ordinary Russian manufacturer, they will reach him as heretofore, indirectly, and escape the

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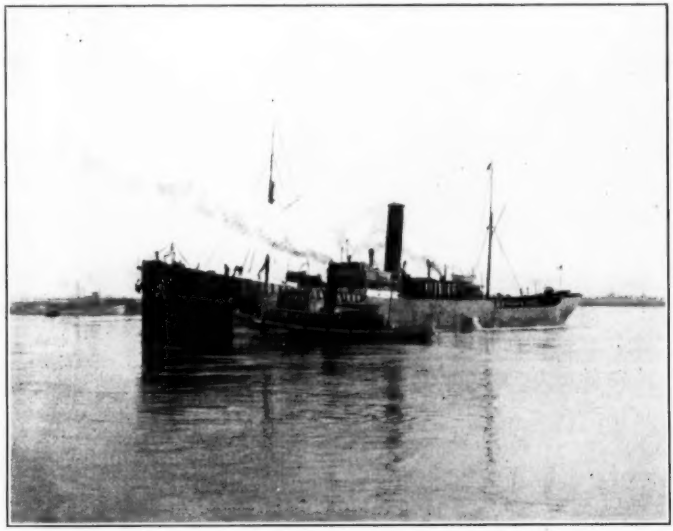
duty. Direct American export to Russia will probably show a shrinkage, Germany and England acting as clearing houses and being credited with Yankee ingenuity. In fact it is estimated that last year these countries sent over $20,000,000 worth of American products into Russia as their own, while the value of the direct export from the United States to Russia amounted to but $11,000,000. It is a common practice to remove the American name plate and substitute that of a German firm. Germany has a great advantage over almost every other manufacturing nation in that the Teutons have established branch



9,000-TON CARGO OF AMERICAN AGRICULTURAL MACHINERY LEAVING THE DELAWARE FOR RUSSIA.

By courtesy of the McCormick Harvesting Machine Co., Chicago, Ill.

banks in almost every large city of Russia, while their agents act as distributors, becoming in time the actual managers of newly established Russian works and naturally favoring home products and machinery. Moreover, Germany sells on long-time credit, while America, without banking facilities abroad, must demand cash payments; consequently the Germans find it profitable to purchase American machinery for cash, change the name plate so that they may secure any duplicate orders, and sell at an advance, on credit, the only terms on which the average business man in Russia can or will buy. The direct orders for American machinery, so far, come largely from the

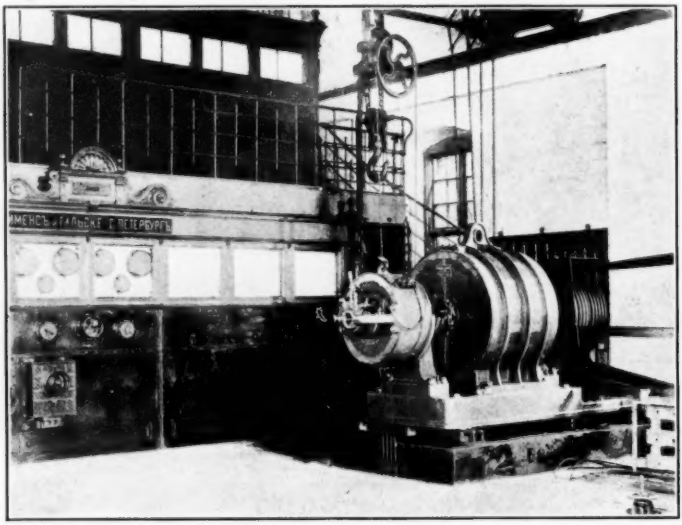
A MC CORMICK REAPER AND BINDER AT WORK ON THE RUSSIAN STEPPES.

Government itself. The manufacturers of reapers and harvesters built up their enormous business in Russia within a few years by sending out their own agents to establish offices and offer the machinery on long-time credit, final payment being often deferred for years until a good crop was harvested. The distributors act also as bankers.

A TRAIN-LOAD OF BOILERS FROM THE AMES IRON WORKS FOR EXPORT TO RUSSIA.

As an illustration of what even a little enterprise will do in the Russian Empire, it may be stated that the sending of a single agent (who spoke Russian) to Manchuria in behalf of the Ingersoll-Sergeant rock drill resulted not only in the introduction of the steam rock drill on the line of the Chinese Eastern railway, but necessitated the use of small boilers, which another American firm was called upon to supply.

It took five freight trains to carry the first order from the factory in America to the tramp steamer in New York on which they were loaded for Vladivostok. The agents for American agricultural machinery had also visited Siberia and Manchuria, so that with their shipments and that of the material needed for the building of the Chinese Eastern railway, enough freight was guaranteed to induce shipping men to put on a regular line between New York and Russian

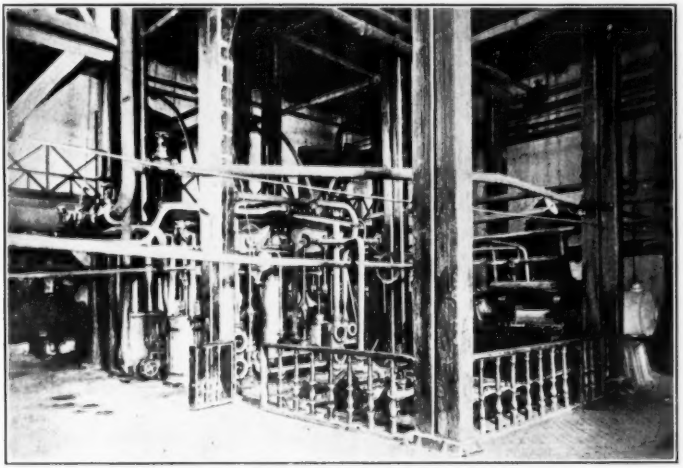


FIRST INSTALLATION FOR TRANSMISSION OF ELECTRIC POWER, NOBEL FRÈRES WORKS.

Far-Eastern ports, cutting down freight rates and opening the way for other manufacturers to enter the field.

As the Far East is but 4,500 miles by water from the Pacific coast of North America and fully 12,000 from the manufacturing countries of Europe, it is but natural to expect that the greatest gains in the export of American heavy machinery, at least, will take place in this part of the Russian Empire. In fact, the building of the Chinese Eastern railway has done more to accelerate the introduction of American machinery into Russia than has any other one cause. It was for the steel bridges on this road that the first large American orders were placed. The Russian Government having ordered that no material manufactured outside of the Empire should be used, the practice of replacing American with Russian name plates became common; but when it was fully demonstrated that the American bridge work could

be landed in Russia at half the cost of production at the Ural shops, the Government began to wink at the orders given by the engineers. As an indication of the progressive methods being introduced on the Chinese Eastern railway, it may be stated that quite recently an American firm was given the order for installing plants necessary for lighting the railway stations with electricity. The new tariff will doubtless induce several American firms to establish branch factories in Siberia. Only recently a large rice-mill plant arriving at Vladivostok was compelled to pay the full retaliatory tariff rate, which amounted to over $63,000. It is expected, however, that this will be remitted, as hitherto Russia has charged no tariff on machinery entering Siberian ports; if not, American-built dredges, when not ordered by the government, will be taxed $20,000 each before they are allowed to enter.

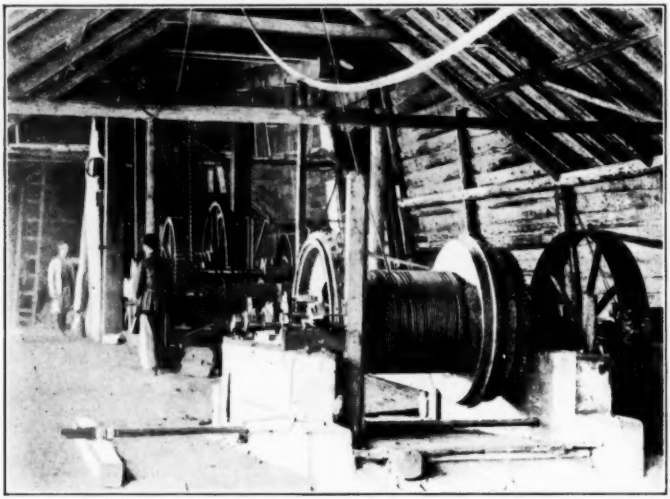


ELECTRIC-DRIVEN AIR PUMPS IN A RUSSIAN REFINERY.

Accredited Russian officials have just made overtures to a Philadelphia firm to establish a plant on the line of the Trans-Siberian railway for the making of steel and the construction of cars and locomotives. A free site has been offered, lumber, coal, and iron privileges are to be granted, while the Government guarantees to purchase a certain number of cars and locomotives annually. The capital of $10,000,000 is to be raised in the United States and the original plant shipped duty-free from American ports. This is but one of the many indications that the Russian Government is willing to make any con-

cession to those who can and will develop Siberian industries. Into Central Asia, cotton gins, cotton-seed-oil machinery, and American compressors, find their way in large quantities, while to the Caucasus region oil-well machinery is shipped, although an Anglo-American firm is now turning out tubing on Russian soil for the Batoum wells that produce more than half the world's supply of petroleum.

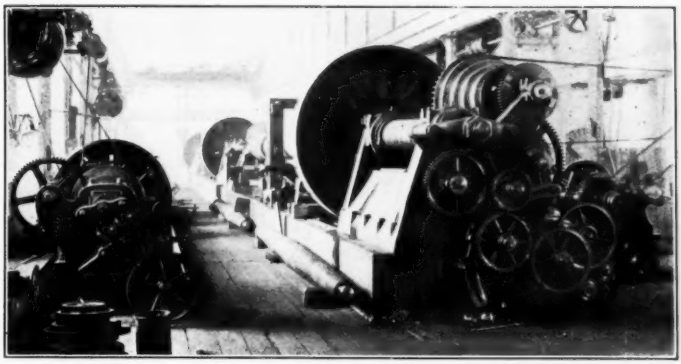
It is in northern and central Russia, however, that American plants and installations are most common. Many tons of machinery are sent every month for the factories going up about Moscow, but it is difficult to trace American machinery in Russia; the manufacturer delivers it f. o. b. New York, Philadelphia, or San Francisco, receives his money, and never gives the matter a second thought. One hundred



INTERIOR OF A DERRICK, SOUTH RUSSIA, SHOWING WINDING MACHINERY.

pumps from one firm alone leave the United States every month for Russia; no one knows where they go in the vast Empire.

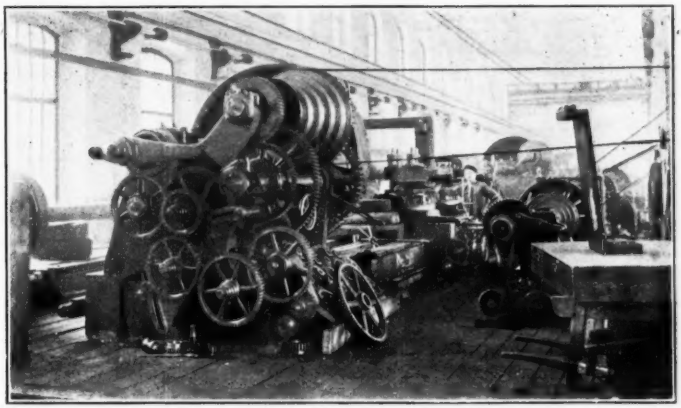
Agents of the Obouhoff Government works, St. Petersburg, visited America last year with a view to inducing manufacturers of air compressors, steam crushing machinery, and dredges, to establish plants for their manufacture in the Russian Government works; in this they have not been immediately successful, but it is interesting to note that in these, the largest works in Russia, employing as they do some 14,000 men, American tools and machinery seem to predominate. The Niles Company has installed at these works several of the largest



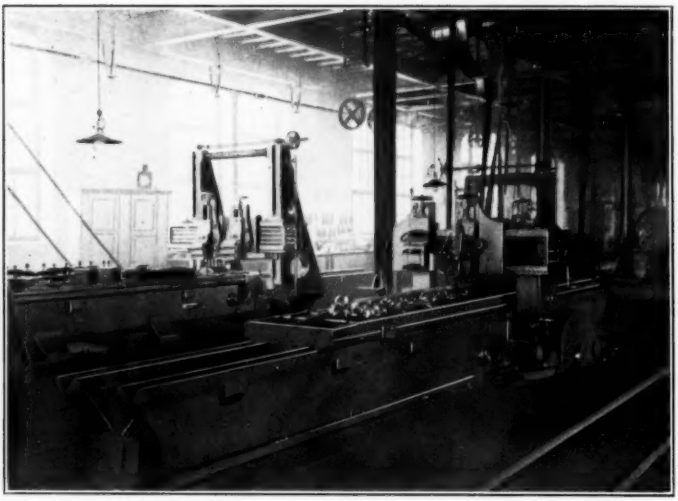
90-INCH GUN LATHES, AT WORK IN THE OBOUHOFF WORKS, ST. PETERSBURG.
Niles Tool Works Company.

gun lathes ever constructed anywhere, while at the Nevsky Mechanical works, also located at St. Petersburg, their American lathes turn out the crankshafts for the Russian navy. At Wiborg, Finland, much of the large plant is American; steel-tired car-wheel lathes and frog- and switch-planing machines turn out work for the State railways.

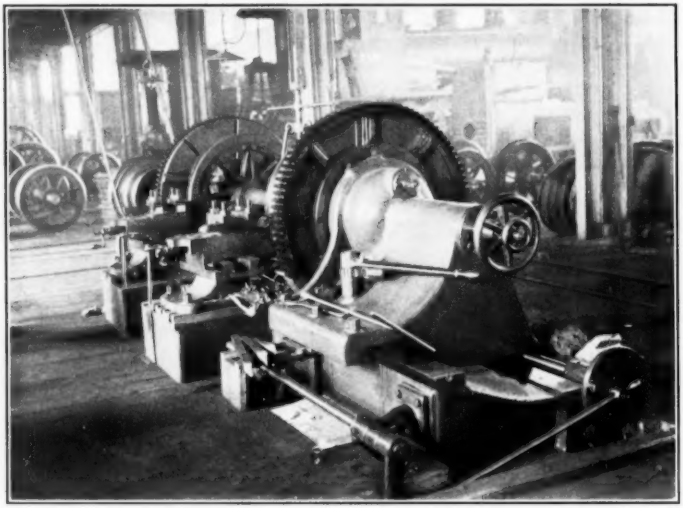
St. Petersburg offers, however, the best present opportunities for American enterprise in Russia. The Neva-St. Petersburg Ring Electric railway is to be constructed, bridges over the river and canals must be built, and of the 400,000 tons of iron to be used at least 60 per cent. will probably have to be imported. Then there is the new St.



ANOTHER VIEW OF THE 90-INCH GUN LATHES IN THE OBOUHOFF WORKS.

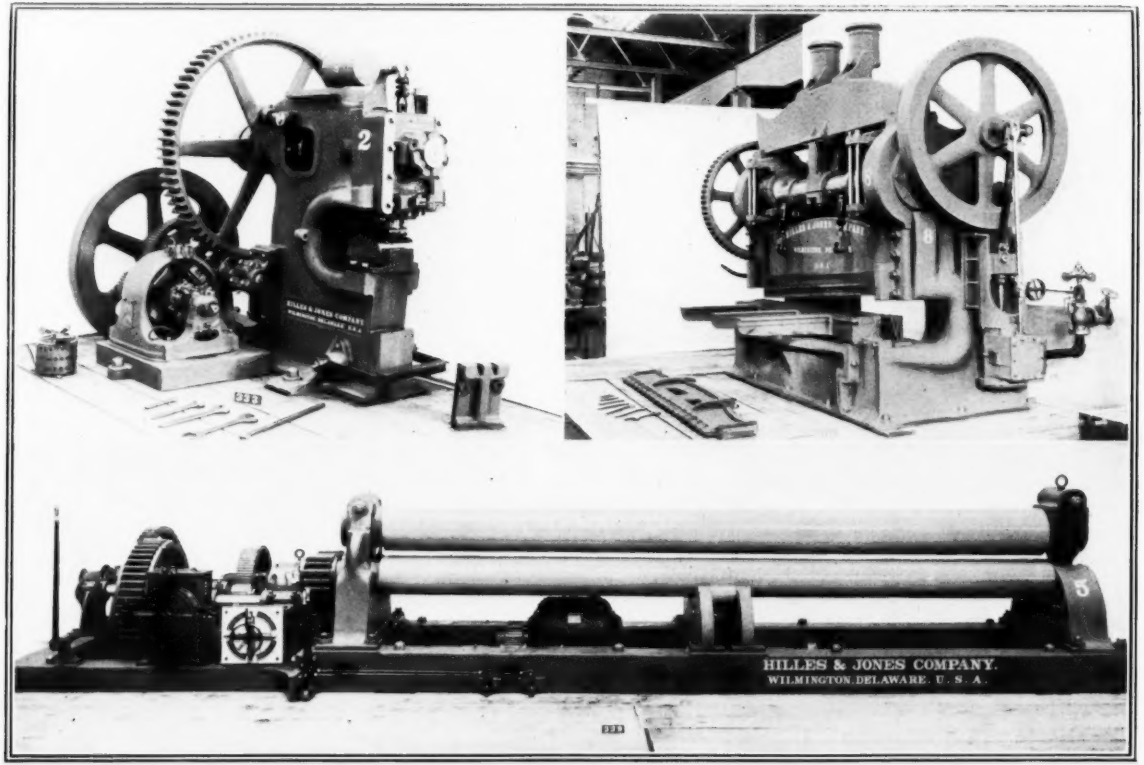


FROG AND SWITCH-PLANING MACHINE AT WIBORG, FINLAND, IN THE SHOPS OF THE FINLAND STATE RAILWAYS.



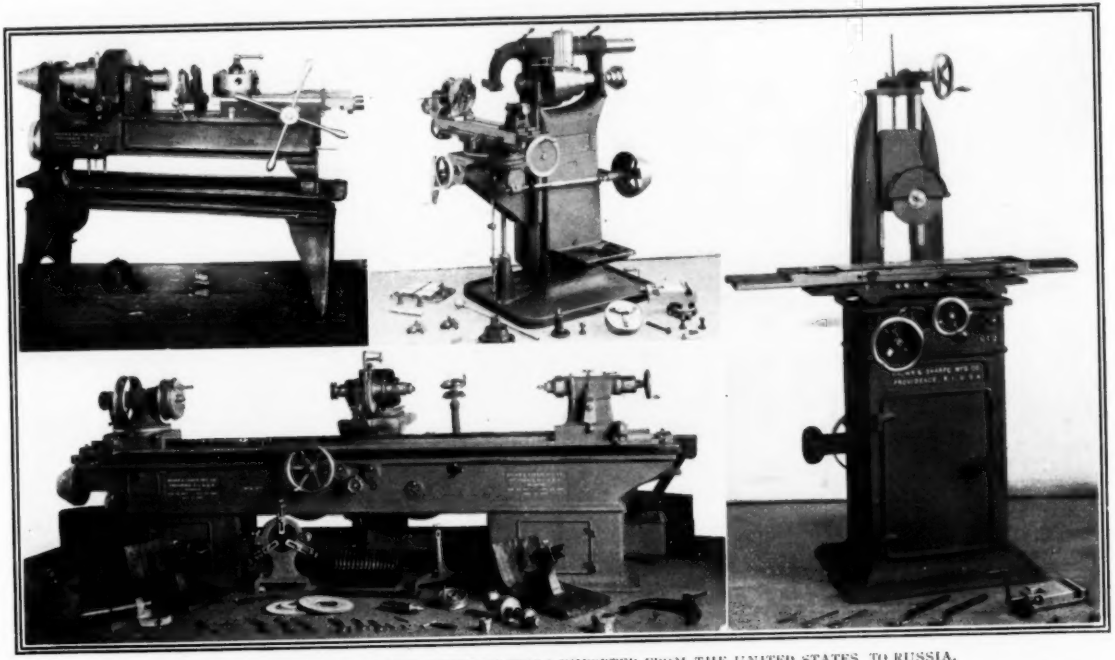
LATHE FOR STEEL-TIRED CAR WHEELS, SHOPS OF THE FINLAND STATE RAILWAYS, WIBORG, FINLAND.

Niles Tool Works Company.



SHIP-BUILDING TOOLS EXPORTED TO RUSSIA FROM THE UNITED STATES.

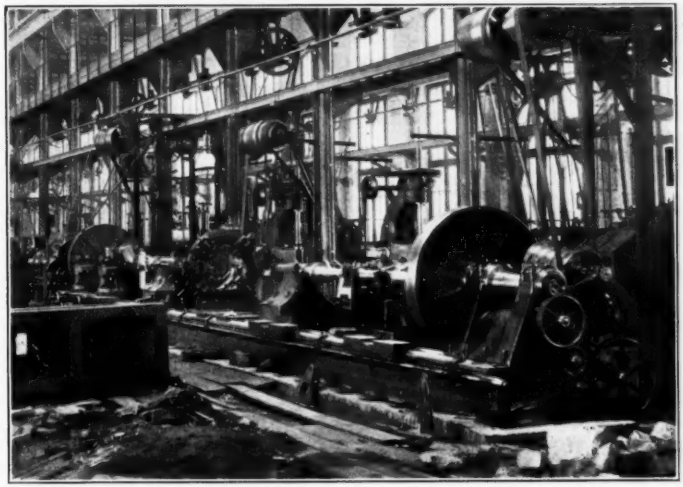
Punching and shearing machines and plate-straightening or bending rolls. Hilles & Jones Company, Wilmington, Del., U. S. A.



GROUP CHARACTERISTIC OF THE KINDS OF TOOLS EXPORTED FROM THE UNITED STATES TO RUSSIA.

Screw machine, universal milling machine, surface grinding machine and universal grinding machine. Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

Petersburg-Moscow Railroad; much outside material will be needed in its construction, for Russia cannot yet manufacture enough rails and locomotives to supply the home demand. Quite recently the Tzar has authorized a railway connection with Viatka, which will make St. Petersburg, instead of Moscow, the Western terminus of the Trans-Siberian railway. The Westinghouse Company has been induced to erect an enormous plant at St. Petersburg for the manufacture of air brakes to equip every freight and passenger car in Russia, while at Saimova, near Nijni Novgorod, the

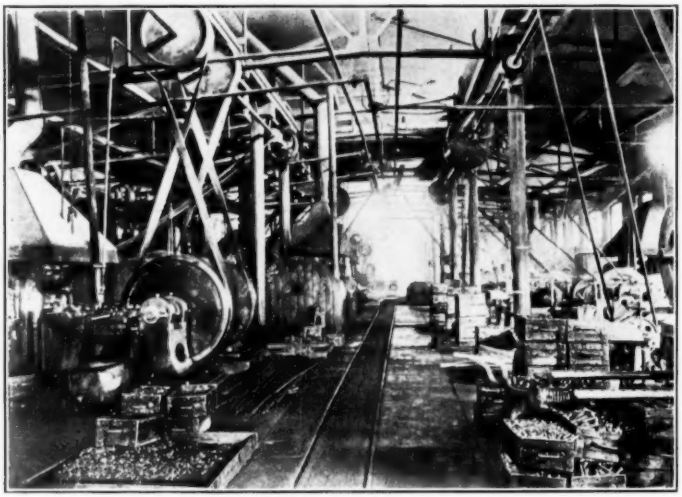


60-INCH DOUBLE LATHE, INSTALLED IN NEVSKY WORKS, ST. PETERSBURG.
Niles Tool Works Company.

locomotive works are equipped throughout with American machinery, 8,000 men are employed, and 300 locomotives are turned out annually, or 500 less than the actual demand. In spite of all her efforts to induce foreign capital to build new machine shops and make her independent of the outside world, Russia still looks abroad for certain kinds of tools and machinery foreigners have made her familiar with. Among the implements I have observed in use in the Russian Empire are: hoisting cranes, scales, planing machines, punches, shears, dies, milling machines, grinding machines, screw machines, compressors, boilers, all kinds of engines, steam rock drills, agricultural machinery, all kinds of railway machinery and equipment, ice-making machines, steam rollers, sanitary supplies, plate-straightening machines, crushing machinery, safes, steam-heating plants, tools of all kinds—so

numerous to mention, in fact, that the list might be stretched out indefinitely.

The Germans are still the merchantmen of Russia, the Slav unfortunately not having successfully evolved from the farmer into the business man. Optimists and pessimists by turns, they organize companies capitalized at millions, merely to corner leather or coal, and are disappointed when the money is lost. A committee of representative Russians met a director of an American rock-drill company on his arrival at St. Petersburg with a request for the agency of the drill; they intended to issue stock to the extent of over a million rubles, the sole asset of the company being the permission of the American company to sell its drills in Russia. These are the incidents that discourage the average business man who visits Russia; but on the other hand there is much room for legitimate enterprise. An American who owns great mines in Siberia has within the past few years shipped millions of dollars worth of mining machinery into the center of Asia, that from the Pacific coast going overland through China on the backs of thousands of camels, while from Reval on the Baltic he has sent an entire trainload 4,000 miles across Europe and Asia, the Government clearing the track for the train and granting a freight rebate which made the expense merely nominal.



BOLT SHOPS OF THE SOCIÉTÉ D L'USINE MÉTALLURGIQUE, OF MOSCOW. OUTPUT 4,000 TONS A YEAR.

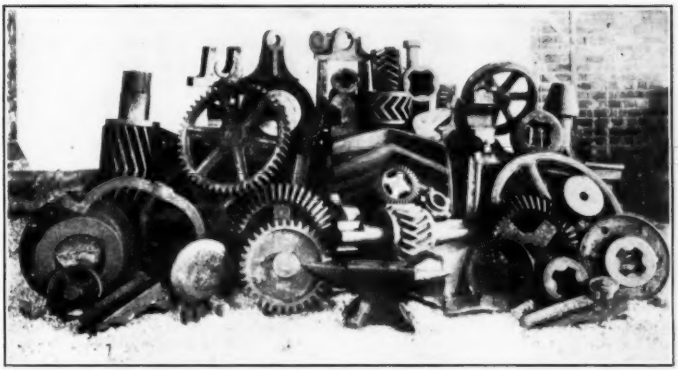
WIRE-NAIL MACHINES, SOCIÉTÉ D L'USINE MÉTALLURGIQUE, MOSCOW. OUTPUT ABOUT 12,500 TONS A YEAR.

Most American machinery destined for Russia finds its way first to Hull or Hamburg. From Hull the Wilson line sends direct boats to America, the Black Sea Ports, and the Baltic; the Russo-American exports are collected at Hull, and when forwarded, as often as not are credited as a British export to Russia. The exports of Great Britain to the Black Sea ports run up in value to tens of millions of dollars, and the Baltic trade is almost as valuable. For over fifty years the United States have been shipping to Russia via Hull; recently, however, Hamburg has become a rival, for the Germans make a specialty of packing machinery and forwarding it to Russia. They understand the intricacies of the tariff system and overcome all the petty annoyances that usually drive Americans frantic, without losing their tempers. After one experience with Russian obstructive methods, the average American shipper of small pieces of machinery is only too glad to deal through the German agent. It is only fair to state, however, that the Russians are remedying their antiquated methods.

While machinery from Germany seems to dominate the market, England also sends immense shipments. The great works of England and Scotland are called upon to equip the Tzar's model sugar refineries, and the immense ice breakers and great dredges are built by British workmen; but there is no denying the fact that in parts of the

Russian Empire, at least, the Englishman is intensely unpopular. For obvious reasons, Russia does not wish Englishmen admitted into her mechanical secrets in the Far East. It is but recently that an English firm, one of the largest doing business in the Far East, employed an American familiar with the price lists of his countrymen to travel over the Chinese Eastern railway to secure orders which were to be filled in America, yet this Yankee material must necessarily be carried inland on steel barges and river boats sent out from Great Britain.

It is not intimated that America is to have a "walk over" in capturing the markets of Russia for her machinery; there are many things militating against the continued use of American tools and machinery in Russia. First and foremost, German workmen are most excellent imitators. Next the loose ways of American exporters militate against them. Take, for instance, their method of packing. Delicate machinery is shipped in open crates; loose parts are wrapped in brown paper and tied with twine to a bar of the crate. Go down to any wharf in New York and watch the machinery for foreign export delivered there. It will be strange if you do not stumble over detached pieces that have become separated from the rest of the engine or lathe. The goods shipped to Russia are paid for before they leave the United States; therefore the purchaser has no redress. There is much in the Russian complaints of American methods. In St. Petersburg the Germans maintain a permanent mechanical exhibit. Russian engineers visit this, see what they want, and order c. i. f. An American agent may be in the city and offer the goods at a far lower price, f. o. b., but he can give no quotation c. i. f. and consequently loses the order. So prevalent is the shipment of American manufactures to foreign markets f. o. b. that recently the president of one of the largest locomotive works in America telephoned to a broker to ask what the initials c. i. f. meant; he stated he had telephoned several manufacturers but they could not enlighten him. He was informed by the ship broker that c. i. f. meant cost, insurance and freight; figured it out, bid for, and got the contract he was after. German and English merchants invariably ship c. i. f. They insist upon knowing just where the goods are going, as they may have an agent in that particular section upon whose territory they are encroaching. The purchaser is bound to sell at a fixed price, from which no deviation is permitted, the broker or middle man not being permitted to take advantage of the ignorance of the consumer. England has large sums invested in Russian industries and knows what implements and machinery are needed; moreover she has a standard, which the United States lack. In America a dealer



STEEL CASTINGS FROM THE SOCIÉTÉ D L'USINE MÉTALLURGIQUE, MOSCOW.

orders a pump, at such a price. In England he demands a Perm pump or a Jeffrey pump, knows the exact price at which he can buy and sell, and would take no other make. The Russians accustomed to this standard system cannot understand the American custom of substituting "something just as good." Other countries study the foreign markets and give their customers what they demand, manufacturing special machinery for each and every market, if necessary, while the American manufacturer too frequently insists on forcing his goods on the foreign purchaser for trial, whether they be suitable to the country or not: if not, a duplicate order is lost to America.

What is needed in Russia to advance American commercial export interests there is a corps of young business men who can speak the language, and thoroughly know the home market. Catalogues must be gotten out in Russian and given to the censor to be passed upon before they can be distributed. An American bank must also be established in St. Petersburg, with branches in several of the larger Russian cities: for the advantage lies with those countries that have banking facilities in Russia.

The manufacturers of other nations co-operate, working for their joint as well as individual interests. In America every firm carefully guards the secrets of its shipments abroad, sometimes going so far as purposely to make out incorrect manifests and to pay the penalty at the other end. When American business men learn to trust each other more at home they will be willing to take chances abroad. American banks will spring up in other countries, f. o. b. shipments will give way to c. i. f. consignments, and American export business will be placed on a solid basis which its rivals will not be able to shake.

THE PROPER DISTRIBUTION OF ESTABLISHMENT CHARGES.

By A. Hamilton Church.

I.—THE NEED FOR INTERLOCKING GENERAL CHARGES WITH PIECE COSTS.

It is self-evident that profitable manufacturing depends on selling the entire product at a sufficient advance over the entire cost. If the output could be dealt with as a whole, this would be an eminently simple proposition. In practice, however, the total sales are made up of a multitude of detail transactions, and each detail lot of product has a cost spread fractionally throughout a multitude of expenditures.

The problem of determining the true proportion of expense attaching to each piece, so that its price may be fixed to return its true proportion of profit, is the vitally important one treated by Mr. Church in the series of articles to which this paper is the introduction. The new light which he throws on the subject of cost keeping will be warmly welcomed by advanced managers everywhere. "Establishment charges" will perhaps be more quickly recognised by American managers under the practically equivalent term expense burden—the total difference between prime cost and inclusive cost of the product of the works.—THE EDITORS.

WRITING no less than sixty-eight years ago, Charles Babbage said:* "The great competition introduced by machinery, and the application of the principle of the sub-division of labour, render it continually necessary for each producer to be on the watch, to discover improved methods by which the cost of each article can be reduced, and with this view, it is of great importance to know the precise expense of every process, as well as of the wear and tear of machinery which is due to it." And in a subsequent chapter dealing with the "causes and consequences of large factories," he points out that in reference to any particular manufacture there will be a certain minimum proportion of indirect expenditure for supervision, lighting, clerical work, passage of materials from process to process, repairing, etc., which cannot be exceeded in any similar factory without a less efficient production resulting.

This is probably the earliest reference made by any public writer either to costs or establishment charges. Yet notwithstanding that

* Economy of Manufacture, by C. Babbage, M. A., London, Knight, 1832.

the importance of such matters was realised by Babbage so early in the development of manufacturing industries, the lesson for various reasons fell upon deaf ears, and it is only today, when the principle of competition has attained its full growth and has become a matter of life and death, that the commercial organisation of manufactories is felt to have become a matter of prime urgency.

In the present series of articles an attempt will be made to thresh out the question of establishment expenditure and its interconnection with costs, not merely of the output as a whole, but of the piece and process in detail. To many persons who have not given sufficient attention to the matter, such a problem will present itself, in the first place as hopeless, and in the second as superfluous. Show a person of this type how he can reduce his pay roll by £50 a year, and he will listen with respect. Hint to him that knowledge is power, and that absence of knowledge is weakness, and he will be alarmed, not at his own ignorance, but at the prospect of what he terms "unreproductive expenditure." A firm that will spend its money freely on plate glass and mahogany in its offices, often shrinks from the expense of getting to know what is going on in its shops.

Why is this? The true answer probably is that one is a familiar and conventional item of expenditure, and the other is "something new." One is an obvious and tangible asset, the other an easy subject of criticism for the irate shareholder who remarks "they have nothing of this kind of thing at so and so's." To spend money today for the sake of saving a much larger amount at some future period, even where the certainty is admitted, demands some moral courage; but to expend money for the purpose of raising efficiency, detecting waste, and preventing loss, demands strong judgment and confidence as well. Hence innovations in this department are made much more slowly than changes in the shops.

The difficulty of dealing adequately with establishment charges in their relation to piece and process is usually in proportion to the heterogeneity of the business carried on. In highly specialised businesses working on modern lines, it probably costs no more to maintain a close interconnection of charges and costs than to take out prime cost in any form. But in older places, where all sorts of things from steam engines to twist drills are included in one output, the difficulty is much greater, but on the other hand the need for and utility of such a connection is greater in equal degree.

At what stage in the growth of a business from very small beginnings a fully developed cost and expenditure system becomes a neces-

sity is difficult to say. But that it should be introduced as early as possible is desirable for reasons unconnected with its immediate use. In a small works under the personal supervision of the proprietor, who is able to give so much of his time to the affairs of the shop that he is fully conversant with the progress of work through it day by day, a cost system of any kind has but little present value. But as it is in the nature of new businesses to expand into large ones, and that sometimes with considerable rapidity, with a consequent loss of grip of detail on the part of the proprietor, it becomes very important that records shall be available representing what was accomplished in the shop at the most vigorous period of its life, namely, when the need for expansion was becoming felt.

It is a not uncommon experience that expansions do not always produce the satisfactory effects anticipated. During changes of this kind something has evaporated, it is not known what, but the absence of which is recognised keenly enough in its practical effects. The real element varies, of course. It may be a less intense watch on the part of the proprietor, or it may be, with still greater probability, a dislocation of the previously existing relationship between work and the incidence of expenditure, which again may be due to a variety of causes that must needs be recognised before they are remedied.

We have not, however, to consider the case of the private proprietor alone. Probably today the larger number of new businesses are joint-stock concerns from the very commencement of their career. Innumerable companies are formed for the exploitation of some particular patent article, not infrequently under the supervision of the patentee, who presently demonstrates his unfitness for practical business management. How many vicissitudes do concerns of this type undergo, due to changes of management! Every capitalist with a taste for financing inventions can call to mind examples of this class. Every one can remember with what hopes and fears new blood has been introduced, and with what anxiety the next half-yearly or yearly balance was looked for, to lay bare the result of the change.

It is not yet recognised how immensely the task of a competent directorate, to say nothing of the advantages to a stranger coming fresh to a business to take over and re-organise its working, would be facilitated by the adoption, from the very first, of a thoroughly comprehensive method of recording shop work, including the connection of expenditure of all classes with the items of output on which they are incident. No board would think of carrying on operations without a set of commercial books arranged by an accountant in whom they had

confidence, yet the equally important technical records are nearly always treated in an amateur spirit, with the result that no two undertakings collect this information on similar lines. It is commonly left to the taste and fancy of the manager to say what records, if any, shall be kept, and how far they shall represent anything real and useful. So far is this attitude carried that many otherwise experienced business men really and conscientiously do not believe that shop accounts are of any use at all.

Yet the same men would undoubtedly give short shrift to the cashier who shirked the detailing of his petty-cash account on the ground that to keep track of small detailed expenses was not possible, or at any rate not worth doing. Nevertheless, the possible waste represented by an undetailed cash account is as nothing to the possible waste represented by an undetailed wages roll. And still more important is it to remember that, just as the sum of cash expended is made up of hundreds of small items, which are and should be analysed and classified so as to give an intelligible idea of the wisdom of the expenditure, so the productive activities in the shops are made up of innumerable small jobs, which, if properly marshalled, will tell precisely the same tale as to the wisdom of the expenditure on them as the money payments in the cash analysis.

It is true that the broad results of a half-year's work can be read in unmistakable figures in the balance sheet. But the mischief is not only done by that time, but in the absence of proper shop accounts, it cannot be ascertained where is the element at fault. To introduce reform one must first know where reform is necessary. It is no answer to this to say that practical experience supplies the deficiency. A man with a file and a true plane surface can supply a duplicate of that plane surface if he has sufficient skill and works long enough, but he will produce the same result more quickly and surely if he has a machine tool of the highest class to aid him. And in proportion to the accuracy of the machine tool so will be the ease and speed of the performance. A modern system of organisation is a high-class machine tool. It can be done without, but not economically. That is all there is to it. The wise man will make his own choice.

Thus far the argument has been directed to the desirability of a modern method of shop accounting, even though only of the class which merely records, and does not work up the results into new forms. Attention will now be directed to the particular subject of these articles—the connection of work with the expenditure properly incident upon it. It will, of course, be readily understood that this further

development implies the existence of a highly organised cost system. It cannot be worked at all in those cases where wages are merely analysed each week, usually by a more or less forced agreement, into the order numbers on which they have professedly been expended. Such arrangement, though admirable for the purposes of the commercial accountant, is useless for the technical accountant. And while the results required by the former are readily furnished by the operations of the latter, the converse of the proposition is a clear impossibility.

The clearest demarcation exists between direct (viz., allocable,) and indirect wages—between the wages of fitters and planers, and those of foremen, timekeepers, and messengers. But between direct and indirect *expense*, the distinction is not so obvious. Workmen's time is not without exception and at all times being employed on orders for customers or stock. Whilst it is evident that some wages never become direct expenditure on orders, all classes of wages are liable to become indirect expenditure. The same thing may be said of material. For this reason the unit selected from which all the subsequent erection is built up, is neither the wages as such nor the material as such, but the *job*.

A definition must be given of what will throughout these articles be meant by the term "job." In this respect the distinction drawn by Mr. Slater Lewis * between the job and the works order is adhered to. The works order may, and usually does, consist of a considerable number of distinct jobs. Practically the job may be defined as the amount of time spent by any particular workman on any particular piece or similar set of pieces. Thus, a works order for a lathe will include such jobs as: planing bed, cutting leading screw, milling slide rest, etc. If the works order were for six lathes of similar pattern, the jobs would be extended similarly—as, for instance: planing six beds, cutting six leading screws, etc. In the case of work done otherwise than on customers' or stock orders, the job would be for items such as: new screw for No. 45 lathe, altering position of band saw No. 67, etc. It will be evident that some jobs will be charged with material and some not. Mere process work is of the latter class. Generally speaking, while the works order sets in motion the activities of all classes of labour, the job is individual to each man, his day's work being made up, it may be of one job, or it may be of several jobs.

The whole output of a shop, for any given period, consists of a number of jobs, and of nothing else. When we know all there is to be

* "The Commercial Organisation of Factories."

known about these jobs, we can form a very shrewd idea of the way in which things are going in that shop.

Now the elements which enter into the cost of a job are many. To ascertain merely the actual wages and material spent upon it is undoubtedly something, but to consider these factors alone and unqualified as a basis for the comparison of the relative profitableness of work may easily lead to serious misapprehensions.

In many cases the desirability of introducing a third element into the costs becomes at an early stage obvious to the practical mind. The difference between a small cheap tool and some high-class expensive appliance seems to demand recognition in the costs of the work done on either. In seeking to remedy this, an attempt is frequently made to introduce what is termed a "machine rate" into the accounts—a charge per hour for each tool being made and debited to the job, in addition to wages and materials. This is not always an advance, however. While it is easy to see that a charge is desirable, it does not follow that the fixing of such charges is either simple or easy. Usually some arbitrary proportionate rate is made, supposed to represent the interest on capital sunk in the tool, and this reduced to a rate per hour is charged against the jobs done on that tool. The first objection to this plan is that tools are not in constant employment. But the interest, on the contrary, does not cease to run because the machine is idle. Hence this rough-and-ready settlement of the problem is deceptive and may even lead to false conclusions.

This illustration has been introduced here merely to show, by a simple and familiar case, the general tendency of all attempts to deal with shop establishment charges. It is true that by means of the machine rate no more is usually attempted than to burden particular jobs with some of the interest on the machines concerned. But this, though, as we have said, ineffectual even for the special purpose intended, gives a very definite and clear idea of the *principle* involved, viz., the spreading of shop expenses over jobs, job by job, upon some recognised basis closely connected with the time occupied and the way of doing the work.

Even on this rudimentary plan, it is easy to see that the prime cost and the shop cost have become different things. If two jobs take three hours each, the payment for labour being the same in each case, say 8d. per hour, we may have the respective costs of the process 3s. 6d. and 6s. 6d. respectively, if we assume machine rates of 6d. and 1s. 6d. in each case.

But interest is by no means the only item of indirect expense worthy

of being identified with jobs. It is, in fact, one of the smaller of many items. Thus it is that prime cost is in extreme cases not even the larger half of shop cost, and in mass production may even cease to have any tangible value whatever.

Before going on to speak of shop expenses in detail and technically, something must be said of their relation to the administrative side of the business.

Shop establishment charges are, without doubt, in many cases the "lost factor," absence of which makes the difference between success and failure in a commercial sense. There is a wide difference between technical excellence and commercial efficiency. It is not making an article that is the object to be attained, but making it *at a price*. And where various classes of things are being simultaneously made, something more accurate than practical instinct is desirable as a guide when it is required to decide which line it will pay to exploit commercially to the greatest degree. In a very small undertaking this practical instinct may be sufficient, but we are not considering the case of very small undertakings. The moment the work gets too large in volume for all its minutest details to be carried in one head, the necessity for a close analysis and interlocking of expenses with jobs becomes marked.

Nor must it be supposed that the "departmentalisation" of undertakings is more than one step, though certainly a very necessary step, in the solution of this problem. To separate the expenses incurred in or in connection with the work or organisation of each shop does not usually help us to any knowledge of the interior economy of that shop, if more than one class of article are passing through it. In the rare case that a department contains machines of one size and pattern, performing exactly the same operations on a single variety of work, it is true that very little more would remain to be done, but this condition of affairs rarely obtains. Generally speaking, it remains true that departmentalisation is quite a separate transaction from the interlocking of charges with costs.

An important function discharged by shop cost as distinguished from prime cost is the information afforded to the draughtsman when considering the question of design. The designer has to arrange to give full play to the actual conditions of the shop, much as an architect has to consider the circumstances of the site, by which he is often fettered.

It is not a question of producing a purely theoretical plan free from all limitations of practice that he has to study, but how to arrange to make a given article with a given set of plant, and a given

organisation, so that the capabilities of these fixed elements are utilised to the utmost.

It will be evident that the best chance of doing this exists where the actual shop conditions are fully known, and inter-related with the work already done. Great discrimination is of course necessary in considering these factors, but it is the natural course of things that as the industry increases in complexity, the intelligence required to conduct it successfully requires more and more careful training and selection. This is a tendency against which it is useless to protest.

A not unimportant matter on which the shop-charges question has a very definite bearing is that of valuation for stocktaking. When it is considered that the truth of a balance sheet must obtain all its vitality from the valuation of finished work and of work in progress through the shops, the immense importance of a correct basis for such valuation will appear. Unfortunately, there appears to be no sort of uniformity of practice with regard to this matter. In some cases prime cost is taken as the basis of reckoning, in other cases arbitrary percentages are added, and even in these latter there is a divergence of practice. Sometimes they are added to time only, sometimes on prime cost, but in no case, within my knowledge,* is any attempt made to discriminate between various classes of manufactures. Now, a moment's consideration will suffice to show that any system of general percentage must be most unfair. So must the method of basing valuation on simple prime cost. The reason is obvious. All valuation is an attempt to represent certain facts. The facts are indubitably these: the charges incident on a variety of articles as truly represent part of the cost of such articles as the actual direct wages paid on them. And these charges are rarely, it would be safe to say never, identical in their incidence on different classes of articles nor are they constant from period to period. Therefore an attempt to represent their value either by ignoring this factor of production or by applying an arbitrary increment or percentage equally on all, will produce not any approach to facts, but merely a fancy figure, which will be not even constant in its error. It is, in fact, a guess, and not the less so because based on figures. Arrangements of this kind probably originated the unkind saying that figures will prove anything, "except facts."

The cost of production, as dealt with in this series of articles will be considered uniformly as divided into three great divisions. First, the bare cost of wages and materials, which will be called Prime or

* Exception must be made, of course, in the case of works organised on the writer's system.

No. 1 cost. Secondly, the prime cost plus the expense of production incurred in passing through the shops; this I shall refer to as Works or No. 2 cost. Thirdly, the works cost plus the expenses of the commercial management and selling organisation, which is termed Inclusive or No. 3 cost. This classification will be remembered better by examination of the diagram (Fig. 1) which represents the total sale price of an article dissected into its constituent factors.

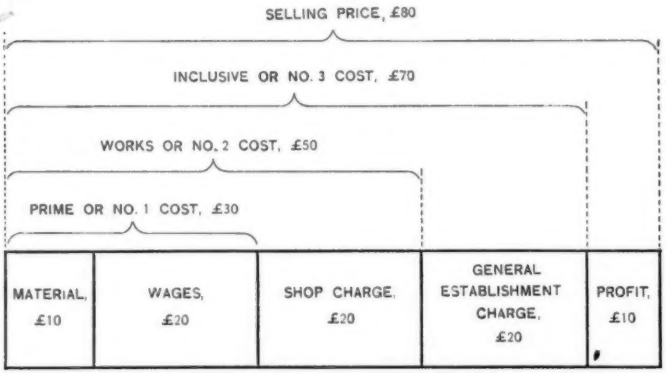


FIG. 1. ANALYSIS OF THE SALE PRICE OF A MANUFACTURED ARTICLE.

In this diagram it will be seen that the cost of materials and of wages, taken together, make up Prime or No. 1 cost. Material, wages, and shop establishment charges make up No. 2 or Works cost. And material, wages, shop charges, and general establishment charges make up Inclusive or No. 3 cost. This last, subtracted from the sale price, gives the profit on that order.

The organisation of no works can be considered complete, until it is able to connect not merely its costs *of all classes* with its jobs, but also to check its financial position by aggregating its profits on sales item by item. Of course the latter process is merely a corollary or deduction from the cost factors. Having ascertained the latter in the form shown by the diagram, the net profit on any sale becomes a trifling matter of arithmetic.

Some attention should be given to a clear understanding at this stage of the very definite line drawn between works cost and inclusive cost. Works cost, as its name implies, represents the expenditure of all sorts upon the work, *up to its delivery* into warehouse. It is the cost of production, and of nothing but production. Inclusive cost is

works cost plus what the commercial arm has spent on it to effect a sale. The distinction will become clearer if we suppose the case of a business having its works in the country, and its commercial office in the metropolis. The expenses of the former would fall into works cost, and the expenditure of the latter would be classed as general establishment charges. It is, of course, understood that all the correspondence, packing, etc., was performed by the metropolitan office, and that the works has nothing to do but to manufacture.

There are, of course, certain expenses which may be doubtful and their inclusion in one division or another is subject to the actual circumstances. Of this kind are draughtsmen. In some cases, the cost of drawings is certainly a works expenditure and chargeable to the job. The same applies to patterns. But, generally speaking, the basis of division is this: If a drawing or pattern is chargeable against a given order, it should be treated as part of prime cost, but in all other cases as a general establishment charge—never in any case as a shop establishment charge.

The necessity for and the justice of this distinction between shop charges and general charges (works cost and inclusive cost) hardly needs insistence. It has been ably and exhaustively argued in the work of Mr. Slater Lewis, already referred to, but the argument may be briefly recapitulated here.

Nothing is naturally more distinct than the operations of making and selling. They require different instincts and widely separate talents. An undertaking may be most efficiently organised and managed on one of these sides, and yet be unsuccessful, because what is gained in one set of efforts is lost in another. What is more useful, therefore, than to make this natural division of work to be reflected by a similar division in the system of accounting? It is the easiest and simplest of all the modifications with which we shall meet, because it is the most obvious and fundamental.

In the articles which follow, works cost will occupy nearly the whole of the field. This is because as yet general establishment charges are not capable of any great amount of detailed analysis. But by keeping them separate and distinct, and thus excluding them from affecting the operations of the works, we are enabled to follow the latter in very great detail, and to feel sure of our result.

Mr. Church's next paper discusses the different methods of apportioning indirect expense to separate items of work.

STEAM ENGINEERING IN PAPER AND PULP MILLS.

By William D. Ennis.

The paper-making industry, while itself specialized, is typical of many lines of manufacture in which steam is used largely for purposes of heating rather than of power. Mr. Ennis paper therefore has a wide scope in possible suggestiveness outside of its immediate topic.—THE EDITORS.

OR the greater part, the development of the paper and pulp industry in the United States has been unaccompanied by the efforts of professional engineers. The pioneers of paper manufacturing belong to that hard-headed and eminently successful type which inherits or assimilates, almost without effort, a species of engineering common-sense that is apt to be amply self-satisfying and usually works out in an incomprehensible way without doing any particular damage to person, property, or pocket. The man in the paper business has had his water power for all of his principal departments of manufacturing, and has seldom been troubled over nice questions of economy in the motive force of his plant.

At the present time, the old and the new stand in juxtaposition. Mills can be found which are operated entirely by steam power, and so economically as to give many a bad quarter-of-an-hour to the old water-power mill man who is "muddling along," gratified at least to know that steam, excepting for the dryers and stock boilers, need not worry him. The growth of the wood-pulp industry, especially in connection with the chemical methods of treating wood fibre to secure stock for the finer grades of paper, has led to the point where, water power or no water power, the steam plant must be one of the first considerations.

Probably in no line of manufacturing industry, excepting in sugar refining, is there so great a range and complexity of operations involving the use of steam as in pulp and paper making. The intricate and varied system of pressures and temperatures necessary, and the extensive use of hot water in processes, give openings for enormous wastes and opportunities for fine economies. Where all low-pressure supplies of steam are taken direct from the boilers, and water for manufactur-

ing is heated by live steam, a mill cannot compete with one driven hydraulically; but when all such services are performed by exhaust steam from the engines, the only difficulty in eliminating the cost of fuel for power is the utilizing of the entire product of exhaust.

In the paper mill proper, the extended use of steam has grown to be essential to large production. Washing and beating are greatly facilitated by the use of boiling water in diluting the stock; and when the equipment is crowded beyond its normal capacity, only live steam will keep the machines supplied. The operations of bleaching are most economically performed when cold water is used; but again, in order to increase production, direct steam must be employed, economy being sacrificed in behalf of capacity.

The Fourdriniers need, in some cases, as much steam as would be required by the engines to drive them. The machine room, which contains the former, requires special methods of heating and artificial ventilation, involving large steam consumption, in order to prevent the vapor, rising from the moist sheet traveling over the dryers, from condensing on the under side of a cold roof and falling on the paper below. The supercalendars require steam to moisten the sheets before they strike the rolls.

In the bleach and rag boilers and in making hot size, direct steam plays an important part. Most of the large mills of America are located where most of the occupied rooms must be artificially warmed during the greater part of the year. All of these conditions result in constantly increasing demands upon the boilers. If the power of the mill is obtained from water, there must still be a system of steam generation and distribution at high and low pressure. The mill owner finds it difficult to regulate or anticipate the demand. His fuel bill is high. He notes that his competitor gets all of this process supply of steam by way of his engines, incidentally letting it expand and do some work. He does not know the amount of his competitor's fuel bill, but wonders, perhaps, if it is any higher than his own. He compares the slipshod, luckless way in which his little steam department is handled, with the business-like system of the other man, and wonders if, after all, his water power is one of Nature's blessings for which he makes no compensation and to which he need give only the scant recognition of a place among the assets of his annual balance sheet.

The dilemma is even more puzzling in a pulp mill, making stock by cooking spruce or poplar chips with steam, in contact with caustic soda, sulphurous acid, or any other substance that will extract the pitch from the fibre. In the sulphite process, the acid is vented as a gas

after having performed its functions, and passes off from the top of the digester, leaving most of the separated pitch in contact with the pulp. The subsequent operations, on which the economy of the process depends, are accomplished without the use of steam or hot water; but the further treatment of the pulp, before it is in condition to be rolled into a sheet of paper, involves a multitude of uses of both.

In the soda process, one of the nicest economies known to manufacturing industry has been developed far toward perfection. Caustic-soda solution remains in liquid form at the temperature at which the fibre is cooked in the digesters. When the blow is made, the fibre, caustic, and resinous extractions pass together into the blow tank, accompanied by a large amount of steam that it seems impossible to save. From here, the mixture is discharged and washed down into the washing pans, where hot water and steam are blown into it until the soda solution, now black and thick from its contents of pitch, passes through the perforated false bottom and leaves behind a comparatively clean fibre. At this point the economizing system enters. The "black liquor" flowing out of the bottom of the washing pans contains two substances—caustic soda and pitch. The former constitutes one of the serious items of expense in the plant. The latter is good fuel.

In order to utilize both of these substances, it is only necessary to burn the liquor. As it returns from the washing pans, however, it is in too dilute a state to ignite. It is therefore evaporated down until it is at a density of 32° Beaumé. This evaporation is conducted in closed cylinders under a sequence of combined steam pressures and vacuums. The thick liquor is then fed into a rotating conical furnace, having its smaller end abutting against an ordinary steam boiler. It ignites at a high heat and forms a very hot, strong flame, the pitch being completely burned, leaving a residue of sodium carbonate, or black ash, which rolls out of the large end of the furnace and falls to conveyors which take it back to the mixing tanks.

The efficiency of the operation, as far as the recovery of caustic soda is concerned, is very high. In some plants, 85 per cent. is attained as the "recovery"—that is, 85 per cent. of the original strength of the soda solution is returned to be used over again. From a steam standpoint, the process is even more interesting. In the process of concentrating the black liquor, low-pressure steam (from 5 to 40 pounds) is used. This is supplied primarily through a reducing-pressure valve or "pressure regulator" of the lever form, which can be adjusted by a sliding weight on the lever. A pump is supplied to feed the evaporating chambers with black liquor, and another to draw out the concen-

trated liquor and deliver it to the rotary furnaces. There must be a vacuum pump and condenser to facilitate the boiling of the solution. The hot drip water from the shells is usually employed in manufacturing processes, and a pump of some kind must be provided to handle it. These four pumps are in most cases direct-acting steam-driven, the exhaust being carried to one of the shells of the evaporator.

If the rotary furnaces could develop a sufficient amount of heat to enable the boilers attached to supply all the steam required by the evaporator and its auxiliary pumping equipment, the process would be ideal, and the cost of operation practically *nil*. This is not ordinarily the case. It is usual practice to take live steam for this purpose direct from the power boilers, and this demand for steam forms a heavy and inconstant load that does not make for great economy as far as the steam plant is concerned. The waste is at a minimum when the pumps are power-driven, the hot drip water properly tempered and wholly utilized, and reserve tank capacity sufficient in amount is provided on both sides of the evaporator so that the demand for steam may be as steady as is practicable.

The hot drip water is not usually employed for boiler feeding. A slight excess over the proper level of the liquor in the tubes results in the passing over of a considerable percentage of caustic soda in solution. In traces, this would be a benefit rather than an injury to the boilers, as it is cleansing in its action and softens the hard scales formed by lime sulphate. An excess, however, causes the boilers to foam violently, and it is the possibility of such an excess that stamps the returning of the evaporator drip as dangerous practice. In washing operations, however, where hot water is necessary, the evaporator drips can be safely and economically employed; but again the process has a flaw, in that the amount of water furnished, while at a suitable temperature, is not ordinarily in sufficient quantity for the work. An auxiliary and supplementary source of supply is necessary, and in producing this another call is made upon the equipment of the steam plant.

Turning again to the recovery department of the process, there is the steam generated by the rotaries to be utilized. If this could be thrown in with the main steam system of the plant, all would be well; but the combustion of black liquor, while violent, does not compare in calorific effect with that of coal. The maximum steam pressure that can be maintained in the former case is about 100 pounds. It is rarely safe to connect rotaries and power boilers into a common system when the pressure is in excess of this. A more efficient proportioning and arrangement of the furnaces and heating surfaces may in the future

facilitate the removal of this difficulty, but at present, in high-pressure plants, a separate disposition must be made of the steam generated in the recovery process. The most efficient and satisfactory scheme of operation, under present conditions, is to pipe the rotaries to a separate steam main. This leads through a pressure-reducing valve to the evaporators. An auxiliary supply to the latter is formed by connecting the main steam system of the plant, through a pressure regulator, with the steam main over the rotaries. The first regulator would be adjustable; the second would be set to reduce from the main-line pressure to that which can be maintained by the rotaries. To provide a disposition for the recovery steam supply when the evaporators are not running, as might be necessary in case of excess reserve liquor between the evaporators and the rotaries, the steam line of the first-named should be connected through a third regulator with the low-pressure heating and process supply system of the mill.

To develop maximum efficiency, the rotaries must be kept clean. The black ash is very light, and rapidly fouls the boiler tubes, smoke breeching, and stack. Where any form of artificial draught is used for the main boiler plant, it is necessary to have a separate stack for the rotaries. It adds greatly to the appearance and performance of a plant to use separate stacks in any case. The boiler tubes should be blown out at least every twelve hours during operation, and should be scraped weekly. When blowing out, unless special precautions are taken, the tubes will not be cleaned. The black ash will return and settle through the tubes round the one being cleaned, and a vent pipe, preferably with a small disk fan inside, should be carried off from the forward end of the boiler setting, to convey away the ash as it is blown through from the back. The smoke breeching should be made of heavy iron, thoroughly braced and guyed. It will not retain its shape if simply hung from straps.

The rotary furnaces, boilers, and black-ash storage departments should be kept in a separate building if possible, or at least walled off from the evaporating apparatus and main boiler plant. It is best to confine the black-ash nuisance within the narrowest limits possible.

The supply of steam required in the processes of manufacturing pulp and paper forms one of the largest burdens on the power plant. Mention has been made of most of the high-pressure work. Many of these requirements could be as well supplied by dripped coils receiving low-pressure steam, of which there is likely to be an ample supply, the condensation being further utilized. In some cases, hot water would fill the purpose usually served by live steam, at least to a large extent.

The obvious method of supplying the Fourdrinier dryers is from the paper-machine engines. These will ordinarily supply an excess, which can be used in the method above indicated, or for warming rooms which require heating, or for heating water. If more low-pressure steam is needed than the machine engines and the rotaries can furnish, one or more of the small engines of the plant could be run on back pressure sufficient to supply it.

The pressure on the dryers must be regulated in accordance with the speed, weight, and dampness of the paper passing over them. This regulation is usually accomplished by means of a pressure-regulating valve of the spring type. The tail rod projecting from the spring terminates in a cross head moving between a pair of guides. The paper passes over a roll which is connected to a cross head. If the paper is not sufficiently dry, the roll will stretch it out, opening the spring and the valve and admitting more steam to the dryers. The supply to the regulating valve is, of course, from the engine exhaust, but live steam, at a pressure reduced to the back pressure carried on the engines, must be provided for as auxiliary. In addition to this, it is frequently desirable to run a higher pressure on the last few banks of dryers than the rest of the machine requires or the engines can furnish. This is produced by live steam, reduced to, say, 25 to 35 pounds. Where the evaporators are not too far from the paper-making department, these two demands might at times be supplied advantageously from a single main line. The drip water from the Fourdrinier dryers should not be wasted. Other sources with which it could conveniently be combined should furnish the initial hot-water supply for the entire plant.

The paper-machine engines, and any other engines that are distant from the power-plant center, need not be highly economical. What is needed of them is a minimum requirement of care and attention with maximum security against breakdown or racing. The exhaust from these engines should all be utilized, in the methods indicated above, for the supply of low-pressure steam for heating and processes. A back-pressure valve on a branch from the main exhaust forms a safety valve to the entire system.

The main engines of the mill, which should be concentrated in a single room, even at a considerable additional expense in driving, should be grouped into two sets. One set should furnish the exhaust steam required for heating water for feed and manufacturing. This will require an engine or engines of indicated horse power of from $\frac{1}{4}$ to $\frac{1}{3}$ the total boiler horse power of the plant. It will run at a slight back pressure, as the heating that could be done in a primary heater placed

between the cylinder and a condenser would not be sufficient. If the demand for hot water can be regulated so as to be fairly constant, and the engine is of suitable size and is suitably loaded, an open feed-water heater will most effiectively utilize the heat of the exhaust steam, raising the water temperature above 200 degrees. The remaining engines should be designed and operated in the direction of high cylinder economy. They should be compounds, supplied with steam at not less than 150-pounds pressure, and should be run condensing. A primary heater can be placed on the main exhaust line, but it should be made large so as not to decrease the vacuum in the low-pressure cylinders of the engines, and at times its use will not be required. The small pumps, condensers, and auxiliary machinery in the boiler house and main engine room should be exhausted into a supplementary heater at a back pressure of 5 to 10 pounds.

Hot water for the various scattered manufacturing processes must, in many cases, be supplied nearest the process served. This may require exhaust or live-steam heaters at various points. The main supply of hot water, for both boiler feed and manufacturing, should be furnished primarily by the drips from the dryers, evaporators, steam lines, engine separators, etc., and the hot discharge water and condensation from the engine and evaporator condensers. These should all be led to a common point, forming the hot well of the plant. The level in this should be maintained at a fixed point by an automatically controlled supply of cold water. A pump, preferably power-driven, placed at such an elevation that the hot water will flow by gravity into it from the hot well, should discharge this water, say at 110 degrees to 130 degrees, to the primary heater or around the primary heater to the open heater above mentioned. From the open heater, the supplies for boiler feed and manufacturing should be kept separate, and if possible, measured. Any further heating on either line can be done in the supplementary heater. The temperature attained by the boiler-feed water at this point will determine whether it is advisable to install an economizer. A net gain of one per cent. for about 12½ degrees of heating above the supplementary-heater temperature could be thus realized.

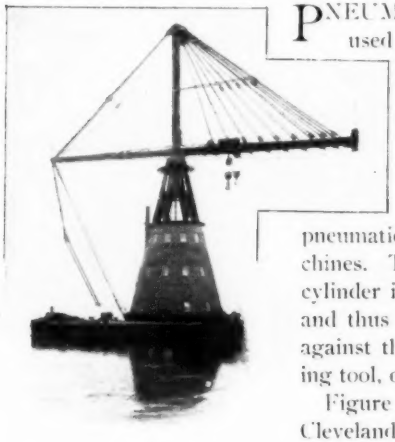
With such an arrangement of engines and water-heating apparatus, with the main power units thoroughly concentrated, and the piping system designed for high efficiency and small loss, with auxiliary pumps power-driven, and with equipment so arranged as to be adjustable for all reasonable conditions of loading, the direct demand for steam in manufacturing is at a minimum, and the steam-driven paper mill may approach closely in economy the modern power plant.

THE MECHANICAL EQUIPMENT OF THE SHIP-YARD.

By Prof. J. H. Biles.

Professor Biles' preceding papers appeared in THE ENGINEERING MAGAZINE for May and June. In them he dealt with the influence of equipment on the cost of production, the essential operations of ship-building, the principal classes of machines required, and the tools for working the frames and the plating.

Electric and pneumatic appliances were necessarily carried over to this concluding article, which otherwise deals generally with general arrangement and transport facilities, and is especially interesting in its comment upon the bearings of the revived activity in ship-building in the United States.—THE EDITORS.



PNEUMATIC tools have not been used to any great extent in British ship-yards up to the present time. In America, especially on the Great Lakes, hand rivetting and caulking have been in a number of cases entirely superseded by pneumatic rivetting and caulking machines. These tools usually consist of a cylinder in which a piston reciprocates, and thus a series of blows is delivered against the end of the rivet die, caulking tool, or chisel, as the case may be.

Figure 57 is a sectional view of the Cleveland pneumatic hammer. Figure 58 shows a section through the Boyer pneumatic hammer for chipping and caulking. The tool is fixed in a bush at one end and the head of this tool is struck by the piston, which is shewn in its furthest back position in the lower figure and in its striking position in the upper figure. The Boyer pneumatic long-stroke rivetting hammer, Figure 59, is a development of the principle embodied in the caulking and chipping hammer. The weight of this hammer, said to be suitable for 1-inch rivets, is only 18 pounds. Perhaps experience in shell work of ships will shew that a heavier hammer will make better work. In conjunction with this rivetting hammer a corresponding pneumatic holder-on must be used, as owing to the rapidity of the blows the ordinary holding-on hammer cannot be brought back into position

between the blows. The pneumatic holder-on is shewn in Figure 73. In cases where the two ends of the rivet are accessible, the rivetter and holder-on are combined in one tool by means of a yoke, but in all other cases, such as for deck, shell, and bulkhead rivetting, the two tools are separate.

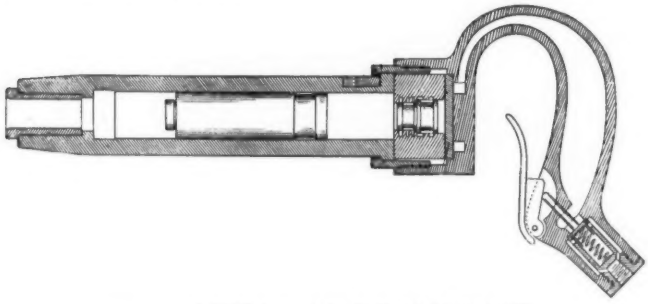


FIG. 57. SECTIONAL VIEW OF PNEUMATIC HAMMER.
Cleveland Pneumatic Tool Co., Cleveland, O., U. S. A.

Yoke pneumatic rivetters are shewn in Figures 60, 61 and 62. For deck work a rivetter of larger type not shewn in the figures is employed. A pneumatic holder-on has to be employed with the latter type, but not with the former. Figures 60 and 61 are photographs shewing the method of working the yoke pneumatic rivetter on a beam and a stringer, respectively, of a ship. Figure 62 shews the small yoke

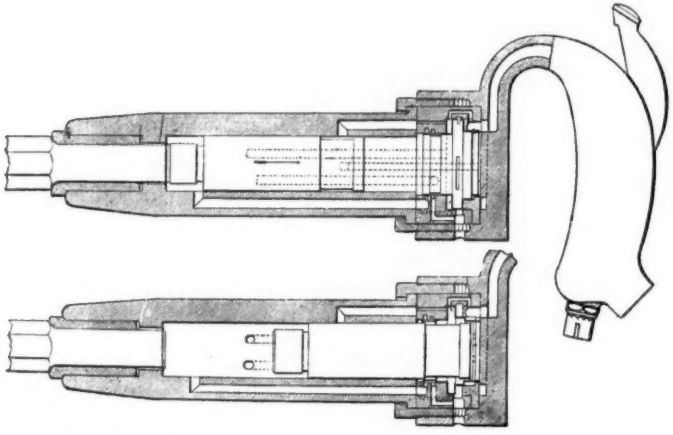


FIG. 58. SECTIONAL VIEW OF BOYER HAMMER FOR CHIPPING AND CAULKING.
New Taite Howard Co.

rivetter at work on ¾-inch rivets in the lower-stanchion connection of a vessel under construction.

Figures 63, 64, and 66 illustrate the methods in which the shell rivetter is employed. In Figure 64 the rivetter is at work driving in countersunk rivets in the lower bilge strake. In Figure 63 it is at work on heavy rivets in flat plate keel, and in Figure 66 on ⅞-inch countersunk rivets in the side of ship.

The present type of tool seems to work well in the smaller sizes of rivets and where there is only double rivetting, but with three or four-ply rivetting, especially with heavy plates, there seems to be a difficulty in properly closing up the work. No doubt with a suitable design of rivetter and holder, and with more experience, this difficulty will be eventually overcome. The advantages of these tools are many, amongst which may be mentioned: The rivets are closed more rapidly and at a higher temperature, the axis of the rivet and tool may be always kept in line, and the holes are well plugged. There is always

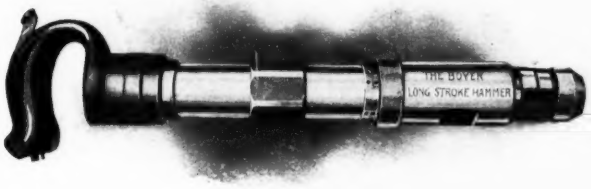


FIG. 59. NEW BOYER LONG-STROKE RIVETTING HAMMER.

Drives rivets up to 1-inch by hand, 1¼-inch in frame; adapted to all kinds of rivetting, including steam-tight boiler work; 9-inch stroke; estimated speed 800 per minute; weight 18 pounds. Chicago Pneumatic Tool Co

this great advantage—that the tools, even when the rivetter and holder-on are combined, are of comparatively light weight, the largest size, with about a 70-inch gap, weighing about 220 pounds, while the smaller sizes run as low as 83 pounds. Mr. Babcock, in a paper read before the Institution of Naval Architects in 1899, gave the following figures as shewing the relative cost of the different styles of rivetting for shell work on one of the lake steamers:

Hand (piece work)	3.99 cents
Hand (day work)	7.69 cents
Air	2.96 cents

The amount that should be added to the machine cost to cover in-

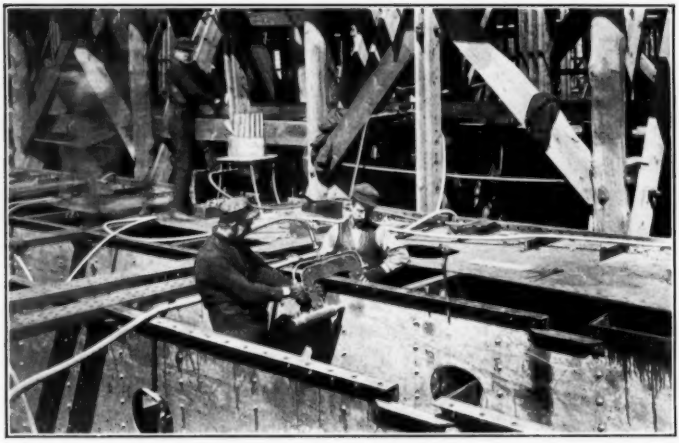


FIG. 60. PNEUMATIC RIVETTER AT WORK ON THE FRAMING OF A SHIP.

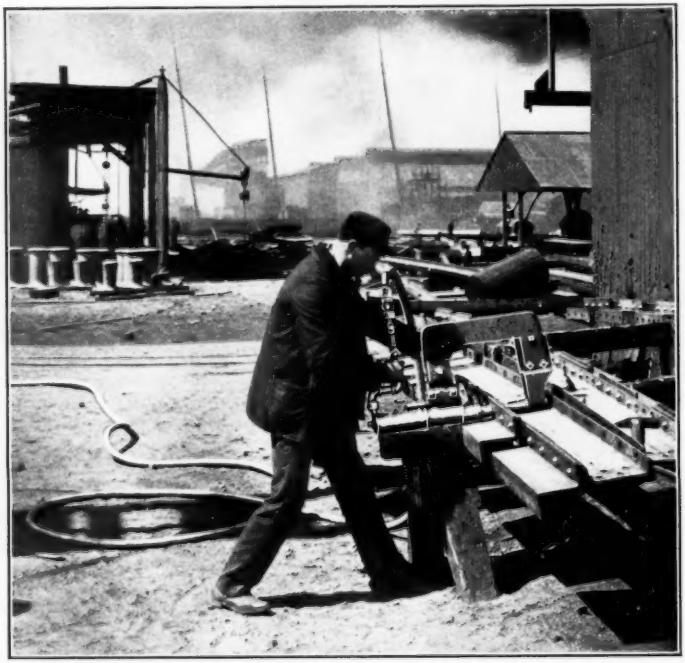


FIG. 61. DRIVING ¾-INCH RIVETS IN SIDE STRINGERS WITH SMALL YOKE RIVETTER.
Courtesy of the New Taite Howard Company.

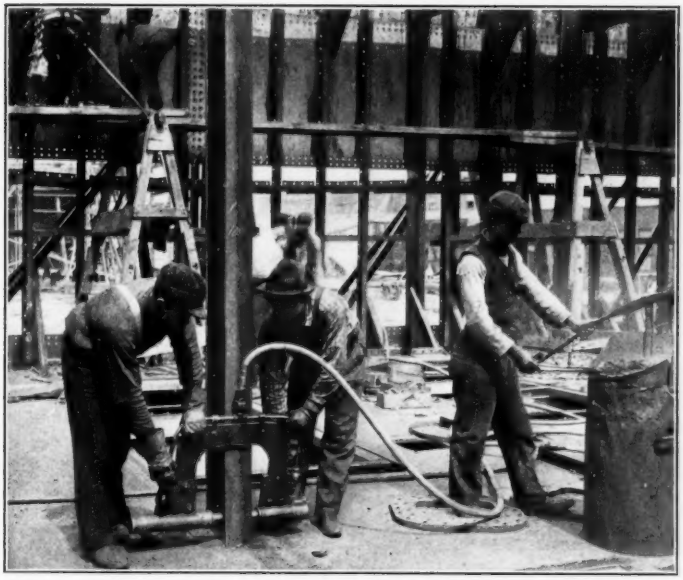


FIG. 62. DRIVING ¾-INCH RIVETS IN LOWER STANCHION CONNECTION WITH SMALL YOKE RIVETTER.

FIG. 63. PNEUMATIC SHELL RIVETTER AND HOLDER ON DRIVING RIVETS IN FLAT PLATE KEEL.

Courtesy of the New Taite Howard Company.

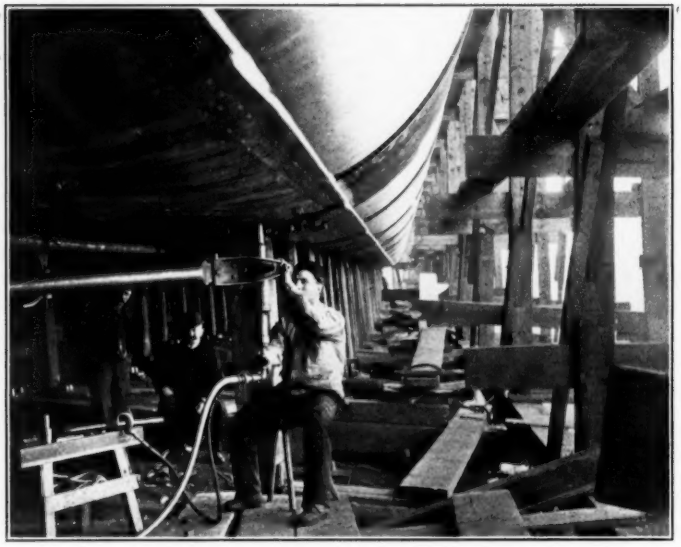


FIG. 64. PNEUMATIC RIVETTER DRIVING COUNTERSUNK RIVETS IN LOWER BILGE STRAKE.

New Taite Howard Company.

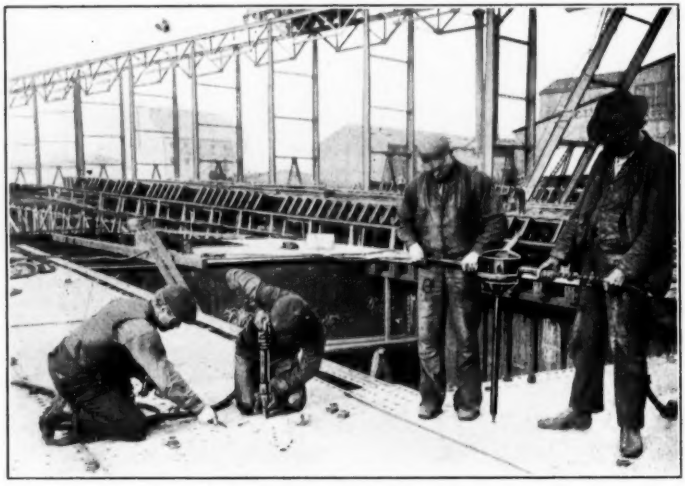


FIG. 65. PNEUMATIC TOOLS AT WORK ON DECK PLATING, CRAMP YARDS, PHILA., U. S. A.

Reaming, rivetting, and caulking with Boyer drill, long-stroke hammer, and chipping hammer.
Chicago Pneumatic Tool Company.

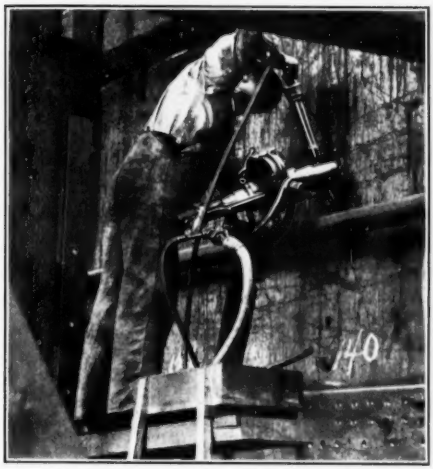


FIG. 66. SHELL RIVETTER DRIVING 7/8-INCH COUNTERSUNK RIVETS IN SIDE OF SHIP. CUTTING OFF SURPLUS METAL WITH BOYER HAMMER.

terest and maintenance is not given, and is naturally much greater in machine than in hand work.

For chipping and caulking in engine and boiler work these tools have been used in this country for some time and have been found to work in every way satisfactorily, and their application to ship work is only a question of time.

For some of the other smaller operations upon the vessel while building, such as boring and punching, pneumatic tools may also be used with advantage. A convenient tool is shewn in Figure 68, which is an illustration of a large pneumatic drill. This drill can be easily reversed; and it is capable of boring a 3-inch hole in metal and is easily portable. Figure 67 shews this drill at work reaming the rivet holes in shell plating.

At the present time a good deal of this work is done by electrically driven tools. A machine thus operated is a common type for drilling decks, and with slight modification the same tool may be used for any other part of the vessel, such as the shell bulkheads, etc. Figure 70 is an illustration of this tool. These tools can

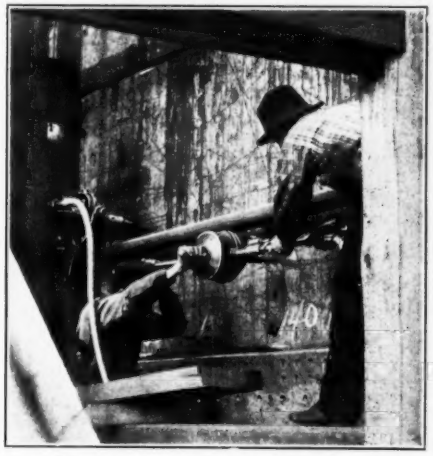


FIG. 67. REAMING WITH BOYER DRILL IN SIDE PLATING OF A SHIP.

FIG. 68. PNEUMATIC TOOL DRILLING 3-INCH HOLE IN STEEL STERN-POST OF BATTLE-SHIP MAINE, CRAMP SHIP YARDS, PHILADELPHIA, U. S. A.

Boyer pneumatic drill. Chicago Pneumatic Tool Co.

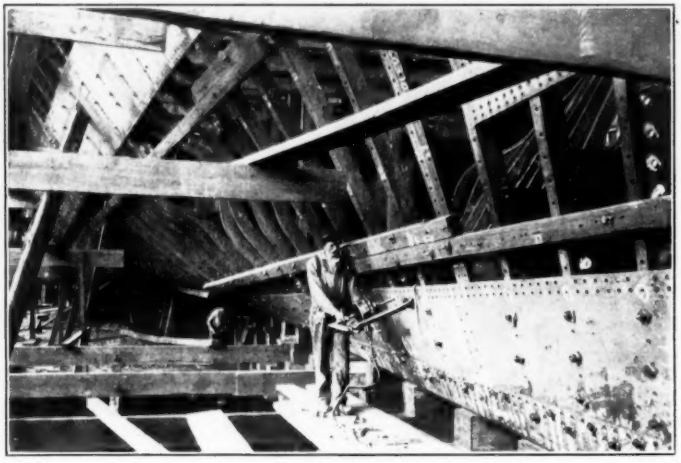


FIG. 69. DRILLING HOLES IN A SHIP'S HULL PLATING WITH PNEUMATIC TOOLS.

Boyer drill. Chicago Pneumatic Tool Co.

also be easily worked by a shaft joined to a motor by a universal coupling. The larger holes, such as sidelights, where formerly cut by hand, are now cut by a tool similar to Figure 72, driven either by hand or electrically; or, if a pneumatic installation is fitted, it may be adapted to this method of driving. Either of the latter forms of power may be

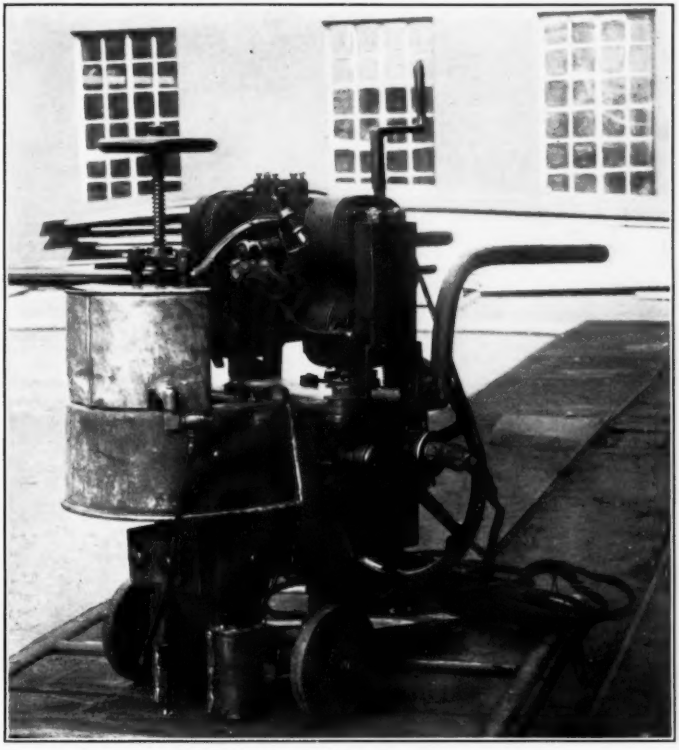


FIG. 70. ELECTRICALLY DRIVEN DECK-BORING MACHINE.

applied to any other small machines used on the vessel, such as deck-planing machines, etc. (Figure 71).

An essential point that should not be lost sight of in connection with all the machines already discussed is the one of upkeep. Independently driven machines, especially those in which steam is employed as the motive power, should be constantly attended to. In some yards it is the custom to employ a man whose sole duty is to test

periodically every machine in use. Small steam engines, such as those used for driving punching machines, etc., are in any case not very economical and usually receive little or no attention, whereas if constantly tested any small defects can be immediately remedied and perhaps not only the life of the machine prolonged, but a saving in the coal bill effected.

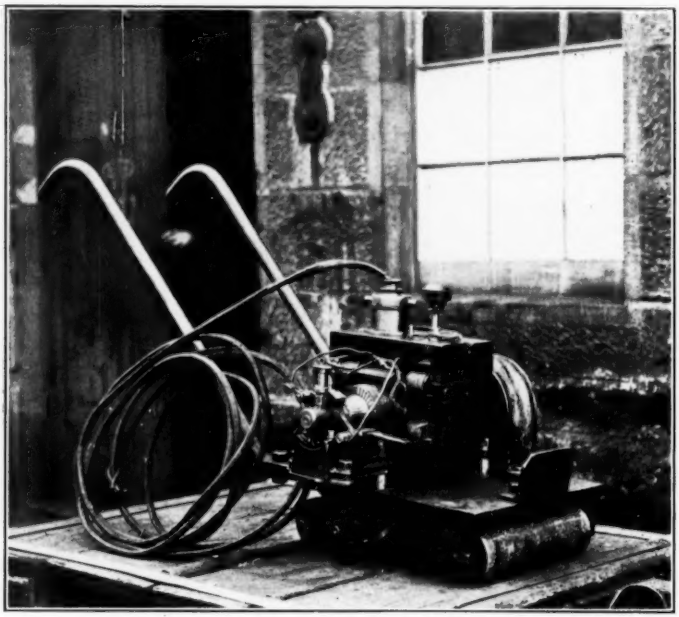


FIG. 71. ELECTRICALLY DRIVEN DECK-PLANING MACHINE.

It is not uncommonly the case that engine shops which turn out the very highest class of work are run by old and inferior engines which the owners of the shops in question would not think of building for sale.

In considering the general subject of the cost of production of a ship, the question of the economic cost of construction is determined to a large extent by the character of the mechanical equipment and the relation of the design of the structure to it. The former has been already generally discussed in the description of the various machines and their arrangements.

The design of structure also naturally affects the cost of putting

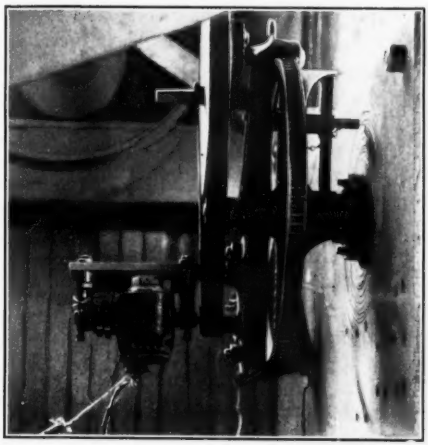


FIG. 72. ELECTRICALLY DRIVEN SIDE-LIGHT-CUTTING MACHINE.

named two considerations go, but a knowledge of the limitations of the steel manufacturer in regard to sizes, as well as a knowledge of the limitations of ship-yard plant, is of great importance. Here we find two things clashing with each other, each very important in the economical production of a ship. On the one hand, the extra cost of workmanship due to having to get a larger number of parts together; on the other hand, the extra cost of machinery or plant (or, rather, the interest upon and depreciation of the extra cost of the structure together, which structure, if made in too many pieces, will cause the work of connecting these parts to add to the cost of the vessel; while if it is made in too few pieces the parts cannot be economically handled, or will involve the use of plant of too expensive a nature for profitable production. Experience often teaches the sizes of different parts of the structure as far as these last-

FIG. 73. BOYER DRILL AND PNEUMATIC HOLDER ON.

the plant) to enable larger pieces to be handled. This is a matter for estimating, but there is evidently a strong inducement to reduce the cost of workmanship by the adoption of machinery, when one remembers that one man's wages is equivalent to the interest on £1,000 of capital. It is also to be remarked that in addition to the saving on the cost of workmanship there is generally an increased output, due to the reduced time which the work takes to do. Take the case of outside plating. Twenty years ago 12 feet by 4 feet was about the normal maximum size of plating. Such a plate

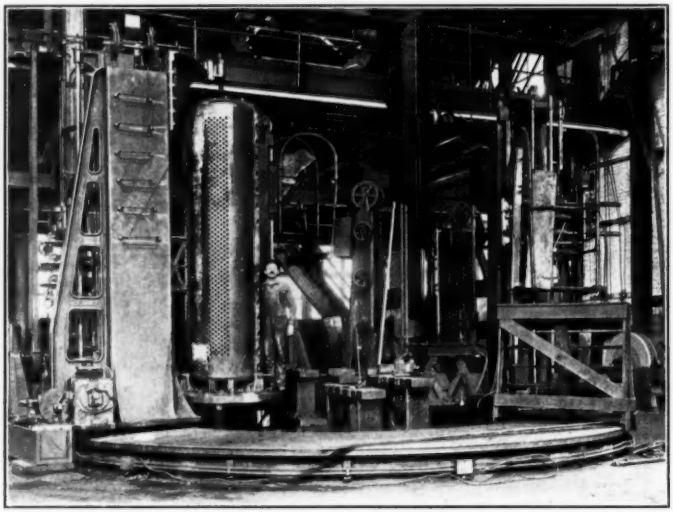


FIG. 74. DRILLING DRUM OF THORNYCROFT BOILER FOR TORPEDO-BOAT DESTROYERS, WITH ELECTRIC-DRIVEN TOOLS, UNION IRON WORKS, SAN FRANCISCO.

would weigh a little more than five-eighths of a ton, and it could be transported on a light barrow and hoisted by plating tackle by the men who were necessary to mark it and punch it. Plates are not uncommonly now used of more than double this length, and of breadth nearly half-as-much again, and of a weight of quite three times. The number of rivets per ton-weight of plate is one-fourth less in the large plate than in the small one. The adoption of such plates involves power cranes, iron railways, and much heavier plant generally. Instead, however, of being able to turn out a ton of ship-building, we should now be able, with the same amount of workmanship and with this improved plant, to turn out more than one-and-a-third tons, a gain of

33 per cent. in output. Increase of plant cannot go on indefinitely, and therefore it is evident that there will be some point at which increase of plant cannot be associated with increase of size of pieces which go to make up the structure, because of the limitations which the steel manufacturer has placed upon him.

The same kind of considerations apply to a great many parts of the equipment of the ship. There is also the simpler question of direct displacement of manual labour by machine labour to do the same work because of its greater rapidity and its less cost. Drilling, caulking, rivetting, are operations which have undergone this change. A ship's structure cannot be made without machines. The type of the machine

FIG. 75. 150-TON REVOLVING DERRICK, ELECTRICALLY OPERATED, FOR INSTALLING HEAVY WEIGHTS ON BOARD VESSELS, SEATING ARMOUR PLATES, ETC.
Newport News Ship-Building and Dry-Dock Company, Newport News, Va., U. S. A.

is determined by the structure, and the structure depends upon the machines that are to make it, so that these two things act and re-act upon each other, and the ship-builder therefore requires to be familiar with the science of the arrangement of the ship's structure, and he has to be familiar with the science of machinery which is to make that structure. The cost of production depends upon the design of the structure and upon the method of putting it together. The design is moulded by the ship-builder to fulfil the two requirements—(1), what the structure has to do, and (2), how it is to be put together. Of

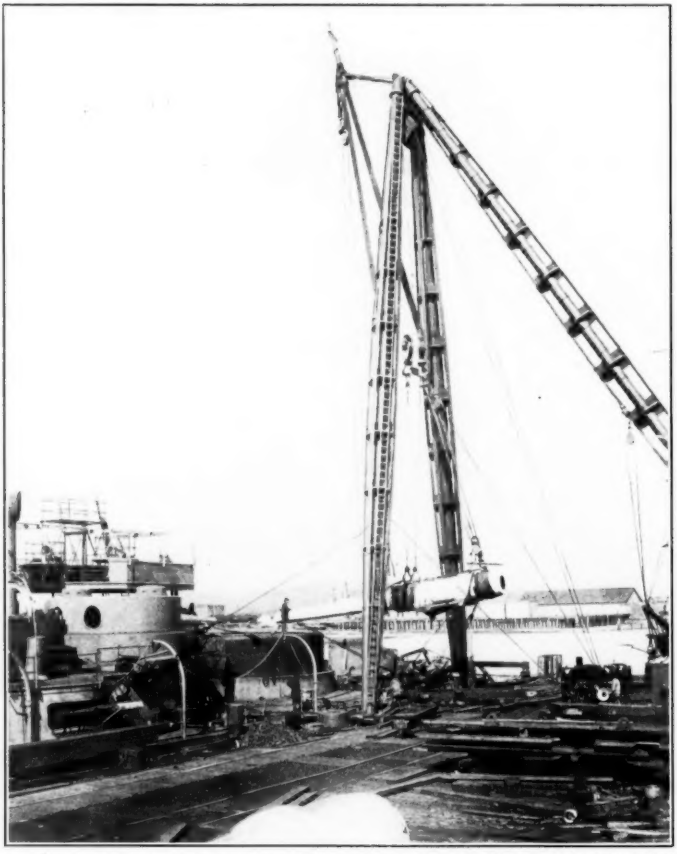


FIG. 76. PLACING 13-INCH GUN ABOARD U. S. S. OREGON AT THE UNION IRON WORKS, SAN FRANCISCO, U. S. A.

course, there are a great many things that go to make up the cost of a ship which do not contribute to the main structural strength. In fact, many of them will involve a greater strength of structure than would be necessary without them.

The handling of material may be generally divided into two parts: (1), transporting while being subjected to the various processes incidental to its manufacture, and (2), erecting and finally fitting in position in the vessel. Both of these items have a very important bearing upon the cost of production. The economy of using as large

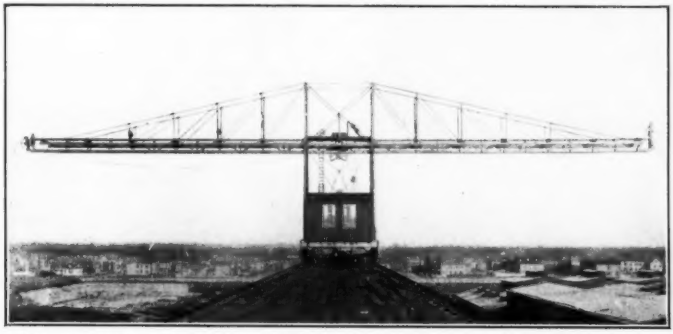


FIG. 77. ELECTRIC TRAVELLING CANTILEVER CRANE, HANDLING 9,000-LB. WEIGHTS OVER A REACH OF 89 FT. ON EACH SIDE, AND 25,000-LB. OVER A REACH OF 55 FT. ON EACH SIDE.

Travels over a trestle 735 ft. long and 78½ ft. high, with building ways on both sides. Newport News Ship-Building and Dry-Dock Company.

plates as possible has already been discussed from a general point of view, but in most cases there is a certain limit beyond which any increase in size, and hence in weight, is accompanied by such increased difficulties in handling as to render any further economy very small, and perhaps the nett economy even less than with the smaller plates. The cost of building in the largest types of ships with the ordinary appliances is usually greater per ton-weight than in the smaller types. Up to a certain limit, say to about 6,000 tons, the cost per ton, as is only to be supposed, decreases; but above this the greater weight of the individual members, such as frames, beams, etc., and the greater heights to which all weights must be lifted, as well as the increased difficulties of keeping the whole structure fair while building, lead to increased expense in handling. This is largely due to the fact that sizes of ships have grown more rapidly than the power of the plant for handling the material of construction. A plant which may be efficient for a certain size of ship may be inefficient for a larger one.

The nearer the capabilities of a manufacturing establishment approach their limits, the more likely are insufficiencies to shew themselves and the cost of production to be thereby increased.

We have already seen the operations that the steel material undergoes in the general process of preparing it for its final position in the ship. The order and nature of these operations and the methods of handling the material have also been discussed.

A great deal of importance attaches itself to the arrangement of and method of stowing the material as it comes into the yard ready for the operations above mentioned.

The necessities of convenience, proximity to the machines, methods and order of working the different parts, the arrangement of material when stored and the appliances for shifting and transferring the parts --all have been considered in the question. For convenience and for classifying the material according to the nature of the first operations on it, it is often stored in two or more places.

Near the furnaces it is convenient to have an open space in which to lay down those parts which have to be heated or shaped at the boards, *viz.*, floor plates, bulkhead plates, frame angles or bars, etc. Shell plates, deck plates, inner-bottom plates, and casing plates, etc., are all stored in a rack or laid out together in a certain way. The method of stowage depends largely on the amount of space available. For occupying the least space, the plates should be stored on edge; but the best way when there is plenty of room is to lay out the plates horizontally, in groups, according to the order in which they are worked. The most common arrangement employed in yards for shifting the material is to have an "in" line down one side of the rack for plates, and an "out" line leading to the yard machines down the other side. Sometimes a traveling gantry is constructed so as to run over and embrace the plate rack and two lines of rails, or one or more travelling jib cranes running on the railway line are employed for lifting or transferring the material. The above method of having an "in" line on one side, and an "out" line on the other is to enable the plates to be put in at any place from the "in" line and to be withdrawn from any place to the "out" line. At the yard end of this plate rack or store, in a yard where war-ships are built, is a pickling trough for the purpose of removing the scale from the plates. For handling the material stored near the furnaces, one line of rail is sufficient and a travelling jib crane is commonly employed. There are definite ways of laying out or storing the material. The ordering of the material from the drawing office is arranged to suit the order of construction, so that

generally as the material comes in to the yard it is laid down in the order in which it comes in. The frames, as soon as they are laid down, have work started upon them provided the scrive boards are ready; then other parts follow in a definite order, so that by experience places for the different parts are allotted. Beams, angle bulbs, stringer bars,

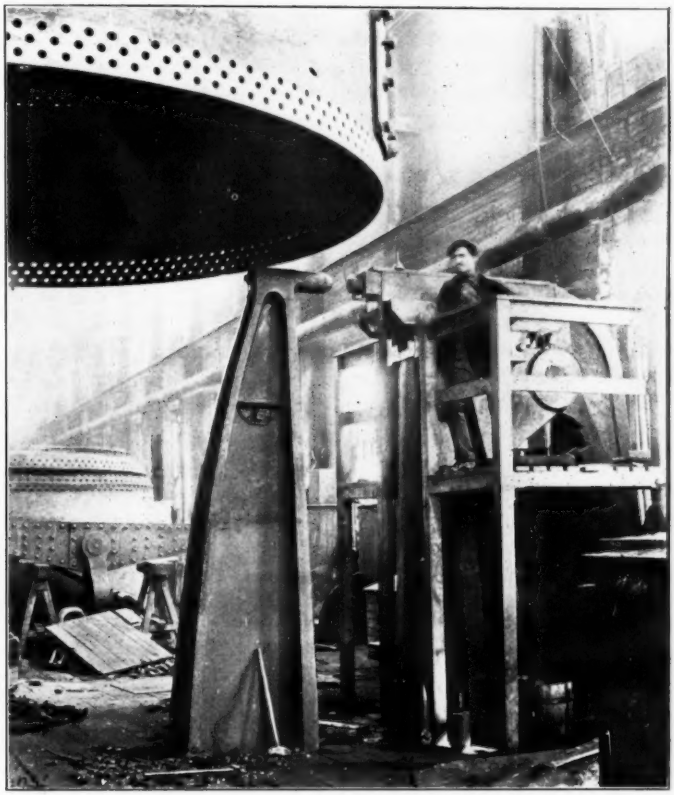


FIG. 78. HANDLING HEAVY PARTS IN THE SHIP-YARD. A LARGE-SIZE SCOTCH BOILER SUSPENDED AT THE HYDRAULIC RIVETTERS, NEWPORT NEWS YARDS.

etc., are usually emptied from the trucks in to an open space near the bending machines or beam shed, where they are picked up and immediately dealt with.

There is also another rack in which spare plates and angles are kept in stock, though it is the aim of every economical manager to have

as little of this as possible and to avoid it by ordering to required sizes. The removal of material from one place to another is performed in many ways. Perhaps the most common is to lay a light railway to all parts of the yard, and upon this to run small cars capable of taking any piece, the cars being propelled by hand. This method is suitable for the transport of a number of the smaller parts, but for the heavier parts, small locomotives, or better, locomotive cranes, will save time and expense in the long run. Take for example a large shell plate. This has first to be removed from the store to some place near the punching and shearing machines. It has then to be lifted by the small cranes attached to the punching machine, and some holes punched from one side and some from the other. It has then to be removed in succession to the shearing machine, the planing machine, plate-bending rolls, sometimes to the plate-straightening rolls, and finally to the countersinking machine. Between each two of these operations the plate has usually to be placed upon some form of barrow and removed to the next machine, and the same process followed throughout. All this, if carried out by hand, involves the use of a number of men and a considerable amount of time, the time expended in handling and the number of men employed varying approximately with the size and weight of the plate. When it is remembered that in a large vessel over one thousand plates in the shell and decks are handled in this manner, it is obvious that anything that can be done to save time during each of the above operations will amount to a considerable saving over the whole ship. From these observations it is evident that all machines for each part of the structure should be placed as closely together as practicable, and if possible so arranged that the cranes of one machine are capable of taking, say, a plate from the machine immediately preceding and passing it on to the following machine. This is not always possible, and perhaps a better method is to fit one or more quick-running travelling cranes over the whole shop or shed, so that the piece may be readily and quickly transferred from place to place. Another method is to support the piece from a runner travelling along a rail over the place where the material has to be shifted. If the store is so arranged that the crane from that part will place the material so that it may be readily picked up by the crane in the machine shop, the whole process of working will be subjected to the minimum amount of manual handling; also, if the final machine is placed as near as possible to to the building berths, and the other machines are placed in their proper order, the piece will in the course of its manufacture be always approaching its final position on the ship.

The second part of the handling process, i. e., hoisting and depositing materials at any point of the ship, is managed in numerous ways. The oldest method was by means of a derrick or pole, four or more, depending upon the size of the vessel, being placed in convenient positions and worked by steam winches. Latterly hydraulic derricks have been used in many situations. A hydraulic jigger or ram is attached to a tall mast which is fixed into the ground; on this mast at a convenient height swings a derrick arm. A wire rope passes from a pulley on the jigger and is led up along the derrick. Another

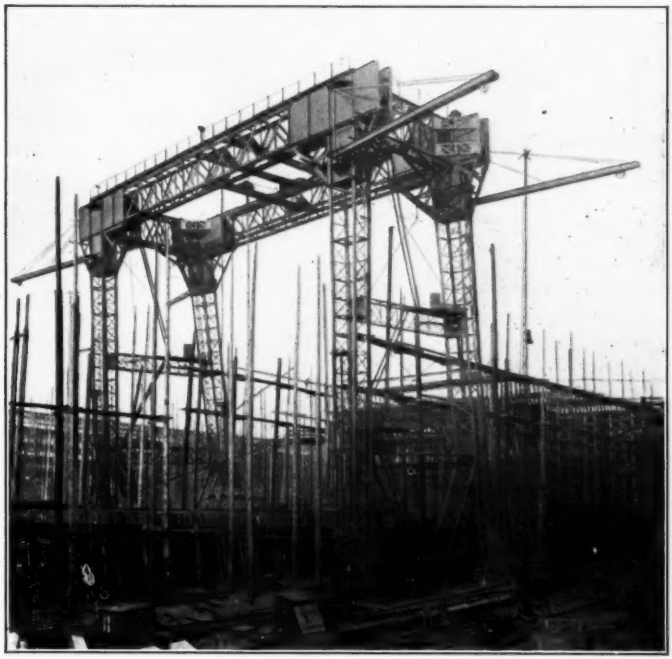


FIG. 79. HARLAND & WOLFF'S TRAVELLING GANTRY.

method, which is in use at the Newport News yard, and has already been described in a number of periodicals, is by means of a cantilever travelling crane. A third method, and one used in the construction of the "Oceanic" at Messrs. Harland & Wolff's, is to have a large travelling gantry running on rails at each side of the vessel for a part of its length. Figures 79 and 80 shew this contruction. A fourth method is that of a framework which is capable of supporting travel-

ling and other cranes, built over the entire length. Of all methods this is best, as it fulfils more than the one condition of hoisting and depositing material. It is shewn in Figures 81 and 82. Now that power rivetting is so much in use, and is likely to increase, the demand for something upon which these machines may be carried and moved from place to place is imperative. The travelling gantry is almost essentially a machine for this purpose, but while it is in use for these machines, it cannot be used for hoisting, or at any rate only to a limited

FIG. 80. HARLAND & WOLFF'S TRAVELLING GANTRY. VIEW OF THE BOTTOM OF ONE LEG.

extent. The shed or framework over the whole vessel, besides carrying one or more travelling cranes capable of depositing materials at any point in the ship, may also be fitted with separate cranes at various points, which support all the necessary rivetting or other machine tools independently of the overhead cranes. The method adopted is to support a bar of ⊥ section between the side cranes and upon this to mount the machine tools, these being slung upon wheels of large diameter running in the flanges of the ⊥ bar, so that the machine may be moved with as little labour as possible. This structure also fulfils another very important condition, in that its sides form supports for the necessary staging round a vessel which, when made of wood, is in itself a considerable item in the cost. It also forms a good means of support for the various stays required to keep the vessel fair in the earlier

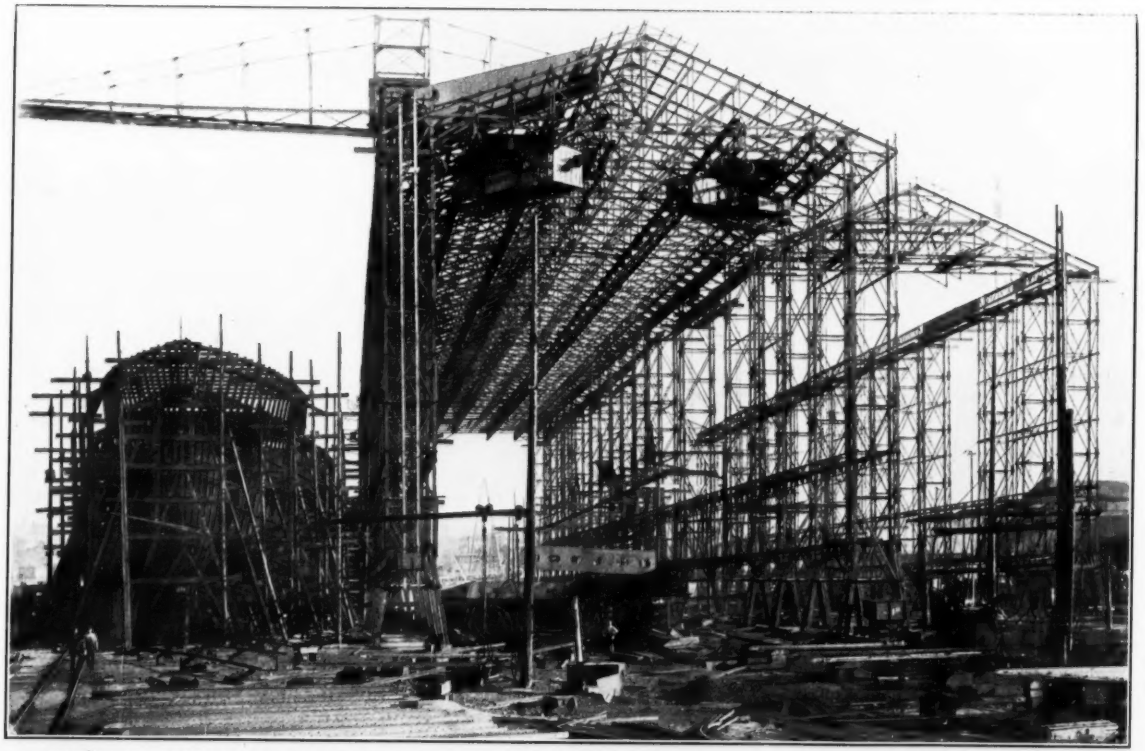


FIG. 81. SHIP-BUILDING SHEDS WITH OVERHEAD CRANES, YARDS OF C. C. SWAN & HUNTER, WALLSEND, NEWCASTLE-ON-TYNE.

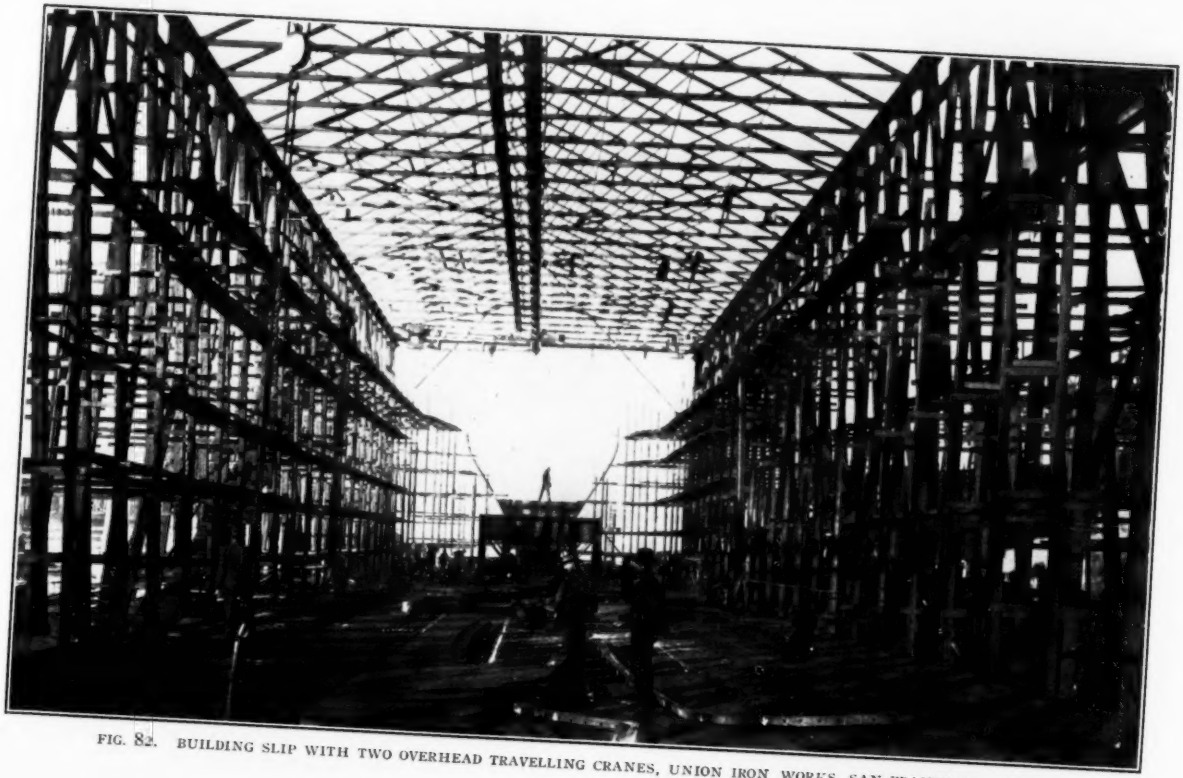
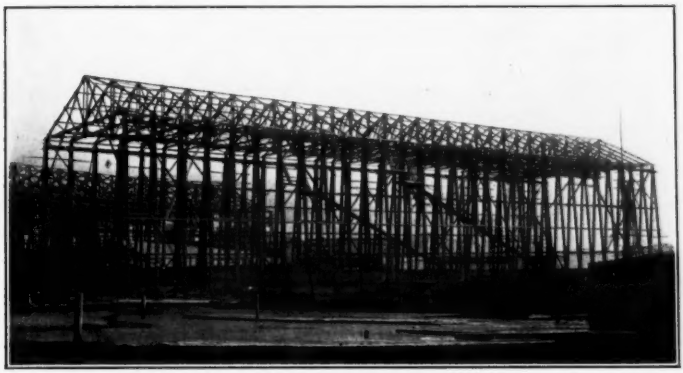


FIG. 82. BUILDING SLIP WITH TWO OVERHEAD TRAVELLING CRANES, UNION IRON WORKS, SAN FRANCISCO, U. S. A.



GENERAL VIEW OF SHIP-BUILDING SHED, UNION IRON WORKS.

stages of construction; this also being an important factor in large ships. Finally, if roofed in, as it may readily be, it forms a shelter against the weather, thereby enabling a much greater amount of work to be done in a given time and all work to be done with much less discomfort. Two cranes may be mounted at each end and used for any lifting purpose or, for example, at the fore end for mounting the machines for rivetting frames and floors.

The first cost of such a structure is no doubt a considerable amount, but the advantages enumerated above will make themeselves felt in a very short time by the decreased cost of production and increased rate of output. If the building berth be in a direct line with the machine shops, overhead cranes may be run from the shops right over the ships.

The foregoing is a brief sketch of ship-building equipment as it has been developed in Britain. Many changes have been made from time to time, as necessity has compelled, but no doubt many more can be made with advantage; and when American ingenuity and boldness has had a few years more development in building large ships, the equipment of a ship-yard will be probably very different. One of the boldest attempts in this direction has been made under the guidance of Mr. Morse in the New York Shipbuilding Coy., of Camden, and the experiment of the most costly labour-saving ship-building plant that the world has ever seen will be watched with the keenest interest. Whether it is before its time, time only will shew; but its full development cannot fail to be of service to the United States, and it is most sincerely to be hoped that it will not be left to a later and more fortunate set of proprietors to profit by the skill and ingenuity shewn.

PHYSICAL AND ECONOMIC FEATURES OF THE UGANDA RAILWAY.

By Frederick W. Emett.

The Uganda Railway is typical of the great engineering undertakings by which England has made highways of civilisation in the darkest regions of the earth. It has special interest on account of its near approach to completion, and its importance in the general scheme of railway development which will proceed with new stimulus as soon as settled conditions are restored in South Africa.—THE EDITORS.

IT should be stated at the outset that in preparing this article for THE ENGINEERING MAGAZINE I do not propose to confine myself to a recital of mere technical statistics and details, but rather to give—as far as is possible within space limits—a comprehensive and general account of the Mombasa-Victoria Nyanza Line, more generally known as the Uganda Railway, an undertaking which it seems to me stands as a monument to British enterprise and endurance in what was once known as savage Africa—a title which is fast becoming obsolete.

At the moment of writing (March, 1901) I read the following despatch from East Africa: "Nearly 500 miles of this line are completed. Soon the lakes will be won and the weary strain over. Wild beasts, wild men, and a wild country have been the foes who have been ably assisted by such auxiliaries as sickness, famine, drought, and loneliness unspeakable. The unknown will soon be an open book to the weakest and most frail." The question of the construction of a line from the East African coast to the shores of Lake Victoria was first mooted in the time of the British East Africa Company, and after a number of railway experts had been consulted the first reconnaissance survey was commenced at the end of 1891. Other surveys followed and maps and plans were prepared, but it was not until August, 1895, that the British Government decided upon the construction of the line. It was settled that the Government would itself do the work and in December, 1895, Mr. Whitehouse, the chief engineer, arrived with his staff at Mombasa.

GREAT SALISBURY BRIDGE, CONNECTING THE ISLAND OF MOMBASA WITH THE MAINLAND, COAST TERMINUS OF THE UGANDA RAILWAY.

The old temporary wooden bridge is shown on the right.

In January, 1896, actual operations commenced and it is hoped that the end of the present year will see British and American locomotives steaming into the station at Port Florence, the terminus of the line, 580 miles from the sea, in the very heart of Africa—surely no mean record for the British engineer! Without taking into consideration the difficulties to be overcome, critics have complained that six years has been an unnecessarily long period for the completion of the work, and as a matter of fact, enquiry was instituted by the Government, who sent out Sir Guilford Molesworth (one of the railway authorities originally consulted with regard to the proposed line) to report, and he stated after exhaustive examination on the spot that the rate of construction had, on the whole, been maintained in a manner highly creditable to the chief engineer and the officers concerned. The various criticisms which have appeared practically ignored three very essential facts: (1), that the country is sparsely inhabited, and that the native of the country will not work even under stress of famine: (2), that water is generally bad, and only obtainable at long intervals; and (3), that animal transport over the first 250 miles from the coast—the "tsetse fly region"—is impracticable, and that porters have to be used.

The first work of the railway party was the establishment of a coast base for the line, Mombasa having been the spot selected, and the erection of the necessary landing stages, piers, sheds, stores, and dwelling houses was immediately commenced. Simultaneously with the establishment and organisation of the base a survey was made for the route to be followed to the crest of the range of hills near the coast, there

being a rapid rise in the first 20 miles to be traversed by the railway. While this work was in progress a party was sent on to Kibwezi, nearly 200 miles up country, to work backwards and eventually to join up with the party working from the coast. The business of the last-named section was to make a detailed examination of the route, to stake out the line for the working parties following behind, and to draw up the necessary working plans. A third party was despatched 400 miles up the road to Kikuyu to ascertain the best route for the

STATION YARD AT KILINDINI, THE COAST TERMINUS.

railway across the main escarpment of the Great Rift Valley, where some of the most difficult engineering was to be expected. At the end of 1897 the first and second parties joined hands, and together proceeded to the point where the third and advanced party had commenced its work. The advance section, which had the most difficult task, completed its labours in April, 1900.

The difficulties encountered by each of these parties were of great but varying intensity. Not only in the earlier days, but right through the period of construction up to the present time, the engineers have had to face one long series of obstacles, not only from the physical and climatic conditions but also from a series of native risings, from famine, and from wild beasts. When the first engineering party stepped ashore at Mombasa they were immediately confronted by a local rebellion which necessitated strong guards being placed over isolated camps

—a very difficult matter, as the troops were needed for operations against the natives and were not available for the protection of the railway works.

Perhaps one of the greatest problems that had to be faced was that of the supply of labour, which not being available in the country had to be imported from India. Sir Guilford Molesworth states that the construction of the Uganda Railway involves an organisation equivalent to the maintenance of an alien army, amounting to over 20,000 men, in a practically waterless country, devoid of resources and of all means of animal and wheeled transport. Even at the advanced workings, hundreds of miles in the heart of Africa, everything had to be imported from a distant country, and from railhead to the advanced parties all stores, etc., had until lately to be carried on men's heads.

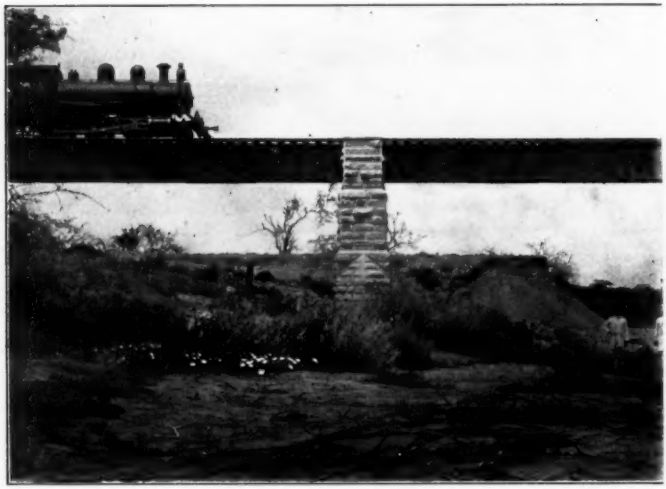
A STATION AND SIDINGS FOUR MILES FROM THE COAST TERMINUS.

Apart, too, from the engineering difficulties, which I will deal with later, the scarcity of water greatly hampered the work; while the depredations of man-eating lions, necessitating the erection of special stockades for the protection of the Indian coolies' camps and involving the death of two officials and about thirty coolies, the prevalence of fever, "jiggers," and ulcers and sores due to the thorn bushes through which the men had to cut their way, and many other untoward circumstances—these constitute a list of difficulties which ought to be sufficient answers to critics who complain of the time occupied.

UGANDA RAILWAY.
SECTION
Line actually staked out.
Line indicated by reconnaissance.
FEET
8000
7000
6000
5000
4000
3000
2000
1000
SEA LEVEL
MILES 550
500
450
400
350
300
250
200
150
100
50
0
LAKE VICTORIA
PORT FLORENCE
Mau.
NAKURO.
Mereinet.
Nakuscha. Water supply abundant.
Longonot Saddle.
Water supply ample.
NYROBI { ample supply of water by gravitation.
Lukenia.
Athi. ample supply of water.
Mechakos Road.
Mtu. Water insufficient.
Sultan Hamoud.
Simba. Water futir, insufficient.
MAKINDO. Water bad.
Kibwezi. Water supply ample, but bad.
Masongoleni.
Mtito Andei. No water in dry season.
Hunyani. No water in dry season.
Kenani.
Tsavo. Water good, and abundant.
Voi. Water supply barely sufficient in dry weather.
Maungu.
Macklinon Road.
Samburu.
Jipi (Thumi. Water 3 miles distant, bad, pumped, none in dry season.
Mackinnon.
Mazeras. Water bad pumped from a distance of 3/4 miles.
Changamwe. Small supply of bad water, pumped from a distance of 1/4 miles.
KILINDINI. Well water good but scanty, supplemented by condenser.
INDIAN OCEAN

To turn to the engineering difficulties, a glance at the profile of the line shows generally that from the coast terminus there is an almost continuous rise to Kikuyu, 350 miles from the sea. In the first 60 miles the line reaches an altitude of 1,200 feet at Mackinnon Road Station, and goes steadily upward until just before reaching Voi (100 miles) 1,800 feet is reached. Thence there is a drop of some 200 feet at the Tsavo river (130 miles), from which point there is a continuous up-gradient to Makindu, where at mile 205 the altitude is over 3,200 feet. Proceeding towards the lake, a sharp drop for 20 miles brings the line to the foot of an incline which extends to mile 280, where Machakos Road Station has been build at an altitude of 5,500 feet. Nairobi (mile 345), the headquarters of the line, is at practically the same level as Machakos.

Beyond Nairobi the line mounts to the Kikuyu escarpment (mile 360) at a height of 7,800 feet. Then commences a descent of nearly 2,000 feet in the Great Rift Valley, followed by a precipitous climb until at the Mau summit (mile 490) the line reaches its highest level of 8,300 feet. The remainder of the railway to Port Florence, the terminus on the Victoria Lake (mile 580), is a continuous drop to the lake-shore level of 3,800 feet. The Great Rift Valley, which I have referred to, extends for several hundred miles and the descent into and ascent out of this valley and descent again towards the lake were the difficult problems in the construction of the railway, so far as the physical features of the country are concerned. For 200 miles from the coast terminus the "tsetse-fly belt" extends, and in this zone, which is covered with dense thorn, no beast of burden can live. In the Kikuyu and Mau districts primeval forest and almost impenetrable undergrowth rendered the progress of the work extremely difficult. In a recent paper before the Royal Engineers at Chatham, from which I have been permitted to extract a large number of technical details, Mr. F. L. O'Callaghan, the energetic managing member of the Uganda Railway Committee at the Foreign Office in London, said that the ruling gradient for the coast section of the line was 2 per cent. with 10-degree (573-feet radius) curves as a maximum, and that the same ruling gradient has been used over the Kikuyu and Mau ranges but in combination with 7-degree (816-feet radius) curves. He added:—"Wherever the permanent working section showed heavy earthwork, which could not be completed in time to allow of the rails being laid over them, temporary lines, or 'diversions,' were marked out with gradients as steep as 3 per cent. and curves of 14 degrees. On the first portion of the railway up to Nairobi there are no less than



THE BRIDGE AT TSAVO.

The engine is American built.

40 miles of diversions, while on the remaining portion of the line these temporary lines will not fall short of 44 miles. Many of these temporary works were of considerable magnitude: the first of these was the temporary bridge connecting the island of Mombasa with the mainland, while every river and ravine met with had to be temporarily crossed by bridges constructed of sleepers and girders. Many other temporary structures—such as stagings for water-tanks, etc.,—were required." The first engineering difficulty encountered within two miles of the coast terminus of Kilindini was the crossing of the Macupa strait, an arm of the sea dividing the Island of Mombasa from the mainland. The original scheme was that this should be done by means of an embankment, but as the channel has a depth of 12 feet at high water, with a 4-knot tide, this was found to be impossible, and it was decided to erect a bridge. A temporary timber bridge (one third of a mile long and involving a diversion of nearly two miles) was completed in August, 1896, when platelaying was at once commenced and for nearly three years the whole of the traffic was carried over this structure until the opening of the fine Salisbury bridge, which now spans the waterway. This long steel bridge, erected on screw piles, was completed in June, 1899, and is the principal permanent structure on the first 360 miles of the rail-

THE OTHER HALF OF THE TSAVO BRIDGE.
Showing provision for flood stage of the stream.

way. Its spans are 60 feet, and on top of the girders is a roadway with a footway for men engaged on the railway.

Immediately after leaving Kilindini the formidable ascent of the Rabai Hills is commenced, a work which involved some of the heaviest work on the line in embankments and cuttings, and during the construction of these heavy works it was necessary to put in a considerable length of temporary line with gradients of 1 to 30 and curves of 400-feet radius. At mile 50 the line enters the Taru Desert, and the section more nearly approaches a surface line. Here the difficulty was not in the construction of earthworks, but in the clearing of dense thorn jungle and the grubbing up of the stumps. The Taru Desert extends to Tsavo (mile 132), but beyond Voi station (mile 100) there is a ruling gradient of 1 in 66. The bridge of four spans of 60 feet over the Tsavo is the second largest bridge on the line. The other girder bridges of 40-feet span and upwards are of three types as regards piers and abutments; (1), masonry piers and abutments; (2), piers and abutments of concrete; (3), trestle piers composed of steel cylinders filled with concrete and braced together. The largest single-span girder bridge on the railway is 100-feet clear span. In the ascent and descent of the great Rift Valley some very heavy and difficult work has had to be carried out. For the descent from Kikuyu to the

floor of the valley 13 miles of line is required and no less than eight ravines have had to be bridged on this section by steel-trestle viaducts varying from 120 feet to 780 feet in length and from 32 feet to 85 feet in height at the deepest points. These viaducts are erected very rapidly by means of a traveller with a long jib. Leaving the valley, the first 15 miles of the Mau Range (the highest section of the line) is easy, but this is followed by over 70 miles of country which

PERMANENT LINE ON THE KIKUYU ESCARPMENT.

will involve the most costly and difficult work of the whole line. In this section there will be no less than 28 steel viaducts varying from 160 to 880 feet in length and from 30 to 110 feet in height. 46 miles from the Lake terminus at Port Florence there will be a tunnel of 200 yards in length, the only tunnel on the whole railway. Between Kikuyu and the lake, some very heavy temporary works have been necessitated for the negotiation of the gradients during the construction of the permanent way round the escarpment. As the portion of the line descending into the Rift valley would have occupied more than a year in construction, a rope incline was built for the purpose of lowering materials into the valley. This lift or incline overcomes a difference of level of 1,523 feet and is in four sections. Two of these have gradients of 16 per cent. and 9½ per cent., are laid with double lines, and by means of carriers with horizontal tops attached to steel hawsers running over a drum, on which the waggons are placed,

trucks are run up and down the inclines. The full waggons going down haul the empty ones up, the speed being regulated by brakes on the drums. The two middle portions of the incline have gradients of nearly 50 per cent.

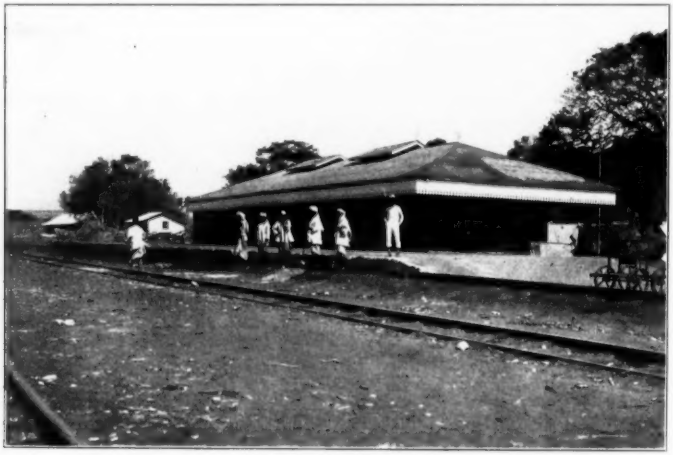
Having dealt briefly with some of the difficulties encountered by the engineers in the construction of the Great African line, a few figures regarding the stations, rolling stock, etc., will not be inappropriate.

The whole of the line is single except at the stations and is of one-metre gauge, the rails being of the Vignoles section, 50 pounds to the yard. Wherever possible steel sleepers have been employed, but where the condition of the soil did not allow of this, creosoted wood has been used. Nairobi is the headquarters of the line and round it a considerable collection of galvanised houses has sprung up. This place (mile 326), 5,600 feet above sea level, is the last bit of level plain be-

TEMPORARY HAULAGE LINE OVER ESCARPMENT AT KIKUYU.

RAILWAY OFFICIALS AND THEIR TRAIN ON THE UGANDA RAILWAY.

fore entering the broken and difficult country adjacent to the Great Rift Valley. It will be the site of the central workshops and administrative offices. In addition to the two termini there will be engine-changing stations at Voi, Makindu, and Nakuro. The various stations are constructed of corrugated iron with wood linings. There are 92 locomotives on the line, of which 34 are English engines of the standard type and 35 standard-type engines supplied by the Baldwin company in America. These correspond to the Indian "F class" engines. The orders for these latter, together with the thirty-four bridges ordered from the American Bridge Company of a total value



VOI—A TYPICAL RAILWAY STATION ON THE UGANDA LINE.

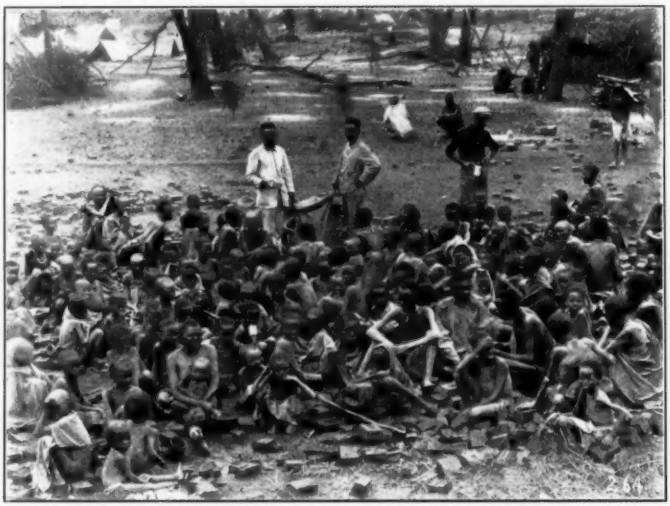
of $1,000,000, were placed in America owing to the fact that English firms were unable to supply them within the required time,—an outcome of the great engineers' strike. The rolling stock consists of 149 passenger vehicles, made in England and of the Indian pattern, 3 horse boxes, 25 cattle trucks, 3 powder vans, 60 special water-tank waggons, 50 brake vans, and 850 goods waggons. In all cases the rolling stock is fitted with steel underframes and all are supplied with central buffers.

Dealing with the prospects of the road from an economic point of view, it is interesting to note that when the line was only open to

A CUTTING NEAR THE HEAD OF THE RAILWAY.

mile 362, the earnings from public traffic amounted to £3 to £4 per mile per week. There should be a great improvement when the rails reach the lake, and when steamers have been launched upon it. At any rate, it is hoped that the traffic receipts will pay the cost of working. The railway has a practical value, however, far beyond the actual amount of revenue it may earn. The saving in transport by rail, as compared with porterage, is enormous to the great advantage of the Protectorates' revenues. In the time of the Uganda mutiny of 1898 the troops and stores were trained up the 140 miles of railway, which had been thus rapidly laid, and the situation was saved. Stores, troops, and other passengers connected with the Protectorate have been conveyed

to the extent of 5,000 tons of stores and 47,000 passengers, including troops. Up to June last the difference in cost of conveying these by rail as against road transport amounted to £300,000. A glance at any map of Africa is sufficient to shew the immense value of this important branch of the Great Cape-to-Cairo system. In connection with the line a service of steamers on the Victoria Lake is being organised for the carriage of local and imported goods over the waters of this inland sea. The boats, which are conveyed to rail head in sections, in which state they are shipped from England, will have a speed of 10 knots when loaded, will be fitted with twin screws and triple-expansion en-



GROUP OF FAMINE SUFFERERS ON THE LINE AT KIBWEZI.

gines, and have a cargo capacity of 150 tons. It is scarcely necessary to point out how this line will completely revolutionise this part of Africa and the effect the iron horse will have on the many tribes living along the route. Sir Harry Johnstone, His Majesty's Special Commissioner, graphically refers to this when he says "The railway has taught the negro the value of honest work; it has saved thousands from death by famine. To the hungry people of East Africa, dying from the result of three years' drought, the railway has brought food and shelter; and no sign of the times was to me more encouraging than to see Masai—actual Masai—who a year ago would have scorned any other avocation than cattle tending, cattle raiding, and the slaughter of other negro tribes, working as navvies on the railway line, de-

PORT VICTORIA—THE TERMINUS OF THE LINE IN THE HEART OF AFRICA.
The natives are carrying sections of a light steamer for service on Lake Victoria.

cently clad for the first time in their lives. The Indian coolie travelling through this land, not of nudity so much as of flagrant indecency, has brought home to the native the fact that his nudity is repulsive. There is probably no more decent land than India, and no more prudish person than the native of India. It is not exaggeration to say that one of the first objects of the Indian coolie has been to put his fellow-workman into breeches. Along the railway line, clothing worn in this sense has become fashionable, and the result is an increased demand for khaki and calico in the Indian bazar or at the white man's store."

The accompanying time-table will prove not uninteresting in this connection. What a revelation to those who until quite recently were

THE TRACTION ENGINE WHICH GOES AHEAD OF THE RAIL LAYERS.

UP TRAINS.			DOWN TRAINS.		
Mombasa	dep.	11 40.	Escarpment	dep.	15 20.
Kilindini	arr.	11 48.	Nairobi	arr.	17 50.
	dep.	12 0.		dep.	10 0.
Voi	arr.	18 40.	Makindu	arr.	18 15.
	dep.	19 40.		dep.	19 0.
Makindu	arr.	4 3.	Voi	arr.	2 0.
	dep.	5 50.		dep.	2 30.
Nairobi	arr.	15 30.	Kilindini	arr.	9 30.
	dep.	9 0.		dep.	9 40.
Escarpment	arr.	13 30.	Mombasa	arr.	9 50.

A word about the goods traffic. At present it is practically all up-country, less than 5 per cent. of the 9,235 tons carried during 1899 being seawards. When the lake is reached there is every reason to expect large consignments of ivory, hides, and horns. Already the railway is beginning to divert traffic from the adjacent German territory, and ever since it was opened beyond Voi, the German stations have been drawing their supplies from the British route while goods hitherto conveyed on men's heads to the German posts on Lake Victoria are now being conveyed via railroad to the lake.

Sir Guilford Molesworth has expressed the following opinion concerning the effect of the railway in the development of this great country: "In East Africa the railway takes the place of roads, which are practically valueless owing to the absence of water and the mortality in transport animals.

"It must be borne in mind that the construction of a railway in a new country often develops traffic from entirely unexpected sources, more especially by checking lawlessness, which might previously put a stop to small trading.

"Broken up as East Africa is into various petty tribes, perpetually at war with one another, it has been hitherto impossible to carry on any trade, except by means of large and well-armed caravans, and even then at great risk. Some tribes have subsisted to a great extent on plunder from their weaker neighbours, so that there has been no stimulus to the more peaceable to produce anything beyond the small requirements of their own tribe.

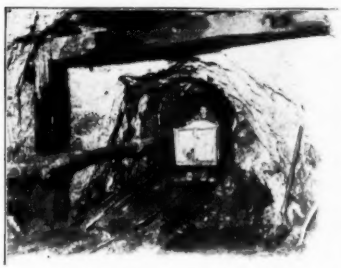
"With the completion of the railway, the whole lake coastline of 800 to 1,000 miles, with the adjoining fertile and populous districts, will be opened up by water communication to railway traffic. And as the Uganda Railway will be the first to tap the lake, the trade of these districts will naturally gravitate into this channel, which will become the established trade route."

The profile and photographs accompanying this article were courteously lent by the Railway Committee.

THE MANAGEMENT AND CONTROL OF THE COLLIERY.

By William Blakemore.

The mine is usually, of necessity, a self-contained community. Its isolation, like that of the ship at sea, compels it to rely upon its own assembled resources and very largely upon its own internal government. It therefore affords a concentrated study of power generation, transmission, and utilization, of mechanical applications and transport, of stores keeping, accounting, and, above all, of labor management. Mr. Blakemore traces the lines of a system broad enough to include and bring into proper relation all of these many functions. The present paper considers underground workings. A following one will discuss surface arrangements.—The Editors.



SINCE the tendency to specialize has been developed to such an extent, the duties of a mine manager have undergone considerable modification, chiefly in the direction of relieving him from details, which formerly made great demands on his time, but which under competent supervision can be as well, or better, performed by men whose training has qualified them to be experts in their own department. This does not relieve a manager from the necessity to fit himself by thorough training and education to be an "all-round man," but it has resulted in enabling him to exercise more efficient control by concentrating his attention upon the more important matters and discharging other functions by the aid of competent assistants. A right understanding and a judicious application of this principle is today the secret of successful management.

In the selection of no career is it more necessary for a young man to consider carefully in advance what are the requirements, than in that of a colliery manager, because there is probably no calling for which a greater diversity of gifts is requisite. Briefly, he requires a robust constitution; a thorough scientific training embracing at least geology, chemistry, pure and applied mathematics; and a practical training of the most thorough character in which he will have an opportunity of seeing how a knowledge of these sciences is applied to the successful management of mining operations. In addition he must

be able to adapt himself readily to varying and extreme conditions of circumstance and environment, and possess both courage and promptitude in dealing with emergencies which may be of a catastrophic character. It is not less necessary that he should be a good judge of human nature to enable him to handle without undue friction, and at the same time with firmness, the workmen whom he will have to control. The absence of any one of these leading qualifications will determine the permanent consignment of a colliery manager to departmental work; the possession of all of them will, with the ordinary qualities of perseverance and character, enable him to rise to the top of the profession and ensure him a position of influence and affluence.

Thus equipped, we will assume that the colliery manager is sent into a new country to search for coal. He will confine his attention to the Carboniferous series if they exist in that section; if not, he must expect to find his coal in the Cretaceous formation. In the former case it is more likely to lie either horizontally or at an easy angle, because less liable to violent upheavals and dislocations. In the latter he may not improbably find his coal in a mountainous district, with outcrops either along the mountain sides at a considerable elevation, or in the creeks where the surface has been eroded and the coal exposed.

In the absence of outcrops he will have to resort to boring; and while for shallow depths of a few hundred feet in favorable ground, that is, ground that is neither too hard nor too soft, boring rods may be used, they have for all serious operations been entirely superseded by the diamond drill, the especial advantage of which is greater rapidity of operation and the securing of a "core" which furnishes more information than can be obtained from "punchings." Even where coal has been discovered it is often necessary to resort to boring, in order to determine its extent, the depth of the seam on different parts of the property, whether there are any large faults intersecting it, and whether the quality and thickness continue uniformly over a sufficient area to justify development. Where the range of outcrops is limited it always pays to determine these facts by boring before proceeding with the erection of plant and the expenditure of capital. It may be mentioned that the cost of boring by means of the diamond drill is much dearer than with rods for moderate depths, but after one thousand feet have been passed the advantage is in favor of the drill. A fair estimate of the average cost of boring with rods to the depth of a thousand feet would be $1,500 and the rate of progress from one to fifteen feet a day. With a diamond drill the cost would be $5,000, but the work would be done in a quarter of the time.

Having thus prospected the property, the location of the mine is the next matter to be settled, and this will be determined mainly by the following considerations: the area to be worked, the output required to yield a profit on the expenditure, the quantity of water to be dealt with, the number of shafts to be sunk, the best position in which to locate the shafts having regard to the conditions of the seams and easiest access to the market. To overlook any of these considerations may handicap a mine permanently. Wherever practicable, it is economical to open a mine by means of an adit from the surface instead of by shafts, thus saving the cost of a hoisting plant, and in cases where the seam is thick enough or the roof favorable for "ripping," to run the main-line locomotive direct into the mine. In case of shaft winnings the quantity of water becomes the most important factor. Formerly it was the practice to locate the shafts in the "deep" in order to have "crop" haulage and natural gravitation for the water, the whole of which was pumped from the deepest part of the property direct to the surface. If however, the quantity be large, modern practice favors locating the shafts nearer the centre of the property and pumping the water from the deep workings by underground pumps.

Where sinking is necessary there are two questions to solve—the form of shaft and the method of sinking to be adopted. The former may either be round, elliptical, or rectangular; this will be determined entirely by the nature of the strata and the necessity or otherwise for walling the shaft. Where the measures passed through are soft and yielding, a round shaft, well-walled, may be necessary; where they are strong and consist largely of rock, a rectangular shaft is much better and cheaper. In very strong measures its size need be limited only by the convenience of the mine, the narrow measurement always corresponding to the length of the cage and the long measurement to the number of compartments required. The method adopted will be governed by two considerations—the character of the strata and the quantity of water; where the latter is exceedingly great and other conditions not unfavorable, the Kind-Chaudron process has been very successful, although costly. One of its strong features is that it allows the tubbing ultimately to be seated securely below the water-bearing strata, and does away with the expensive process of coffering. In Germany and Belgium several successes have been scored by the Poetsch freezing process, but it has not been adopted to any considerable extent. In the ordinary method of sinking, which is of course the most economical when conditions are favorable, it may be found necessary to resort to piling when passing through loose ground, or even

to use boxing or tubbing, and in cases where the water-bearing strata extend for any considerable depth, the shaft will have to be lined with iron tubbing. The average cost of coffering in a round shaft 20 feet diameter may be put at $40 per foot, and for iron tubbing or lining from $100 to $300. The probable cost of sinking such a shaft without pumps would be $30 a foot, with pumps $45, and in hard rock $80. For comparison a rectangular shaft 24 feet by 7 feet with favorable strata has been sunk for $15 per foot where no pumping was required, and for $30 with timbering.

It is important in connection with sinking to bear in mind the necessity for some special provision for ventilation, a matter which has often been overlooked or very inadequately attended to. In large rectangular shafts this can be effected with brattice for moderate depths, but the safest plan is to use a temporary fan and put in ventilating pipes, one of which should be carried underneath the scaffold, whenever the latter is suspended in the shaft, to prevent accumulations of gas.

When the coal is won the "lay out" and the system of mining to be adopted receive the next consideration. The best practice in large mines looking to an output of 2,000 to 3,000 tons a day is the three-entry system, which furnishes better facilities both for haulage and ventilation than any other, and is equally applicable to shaft or adit entry. Mine haulage levels should be driven wherever practicable with a slight rise, not exceeding 0.80 per cent. in favor of the load. The limit to which they can be carried depends upon the nature of the coal, roof, and floor, and the extent of the area to be recovered. Where these are favorable it is probable that no actual limit has yet been reached, although in one case the workings have been carried five miles from the shaft. It may however be taken for granted that under favorable conditions one entry can recover at least ten square miles. The system of working may be either "long-wall" or "pillar-and-stall." In every case the lay out will proceed upon the same principle of utilizing gravitation to the utmost possible extent, and it may here be pointed out that this law lies at the basis of all mining operations, and that there is not one process from the time the coal is cut until it is dispatched to the market which should not be conducted by its aid. The grade of all roads should favor the haulage. The arrangement of handling appliances should leave as little to be done by machinery as possible and as much by natural fall, so that in a well-organized mine the coal will not have to be handled from the moment it is loaded into cars at the face until it is dispatched in railway wagons or dumped

into a coking furnace. If the main haulage is upon levels, the workings will naturally be to the rise, and secondary haulage should be employed to convey the coal from the face or rooms to the levels. If the rise is over 7 degrees this may be done by self-acting jigs, if over 20 degrees by chutes; if less than 7 degrees, rope or electric-locomotive haulage should be extended from the levels. Where the main recovery is a deep one a haulage road should be driven on the full "dip" of the coal, in which case it practically takes the place of a shaft. At a suitable distance the main haulage levels will then be driven at right angles, or nearly so, and the workings carried to the crop as in the first illustration. The system of working to be adopted will depend upon the following considerations: that long-wall requires a good roof and floor, a moderate grade, fairly strong coal, little water, and that the seam should not exceed under any circumstances 6 or 7 feet in thickness. The advantages of this system are that practically the whole of the coal can be recovered, that less pick work is required, especially in shearing, that the superincumbent pressure assists the operation of freeing the coal at the face, that fewer roads are required, that under favorable conditions it is cheaper, and that it makes room for a greater number of men in a given area, and consequently for a larger tonnage. The disadvantages are that the mine suffers much more than a pillar-and-stall mine when laid idle, that it is more difficult to ventilate because of the crushing and closing of air ways, that it requires more timber, that the roads are much more expensive to maintain, and that the workings are more seriously affected by faults.

Where the coal is over 7 feet thick, and in nearly all cases of mining under mountains, it has been found cheaper and safer to adopt the pillar-and-stall system, and in fact it is often not practicable to adopt any other. The chief objection to this system in the past has been the larger amount of pick work required, and a corresponding increase in the cost of production; but since this has been overcome by the introduction of coal-cutting machinery the objection is of less importance. Broadly speaking, however, the system to be adopted must in almost every case depend upon the physical conditions which pertain to the mine. This leads to a consideration of coal production at the face, on which matter it may be stated that all new mines should from the commencement be equipped for the use of coal-cutting machinery. The battle over this has waged long and fiercely, but it has been won, and no colliery manager can in the future afford to resort to hand-pick work where it is possible to use a machine.

In long-wall working the use of what is called the long-wall ma-

chine has been attended with surprising results, as much as 500 tons a day being produced by one machine, at a cost of two cents a ton for under-cutting, under my own supervision. Such a result can only be achieved under very favorable conditions, involving a fairly high seam, strong roof, good pavement, and plenty of clearance at the face. The difficulty hitherto in long-wall workings has been to provide these conditions, and in thin seams it may not be possible. As between the chain machine and the cutter bar, the former is undoubtedly capable of a larger production. In pillar-and-room workings there is a choice of machines; either the percussion or rotary may be used. So far the percussion has been most favored, because it is so much lighter; but upon easy grades the small chain machine, weighing from 2,000 to 3,000 pounds, has demonstrated itself to be a most efficient instrument as compared with the percussion machine. It is safe to say that the latter in good hands will cut an average of three 20-feet rooms for a day's work, whilst the chain machine will cut six to eight. The selection of these machines will be governed also by a consideration of the grade upon which they have to work. The difference in cost between hand mining and machine mining varies from 12 cents to 20 cents a ton, according to circumstances, in favor of the latter.

The question of haulage is the next important consideration, and there is a wide range of systems claiming attention. The manager may use endless-rope or chain haulage, main and tail rope, electric or compressed-air locomotive; but he may rely upon it that if he has thoroughly mastered the conditions of his mine, only one of these is worthy of adoption. For any particular installation on grades not exceeding 2 per cent. the electric locomotive is the most efficient and economical method of hauling in use. At any greater angle of inclination the endless haulage rope naturally takes its place, in fact there are circumstances under which this claims first attention, mainly where an exceedingly large tonnage is required to be moved. Endless haulage has been worked advantageously upon all grades up to 40 per cent., but it is doubtful whether on very steep grades it would not be cheaper to duplicate the entry, and haul direct. On main deeps of a moderate inclination the endless rope is far ahead of any other system, its capacity being practically unlimited, and for the expenditure required no other system gives as good a result. A mine equipped with endless haulage on its main deep or level and either self-acting jigs or chutes from the workings to the main or secondary haulage, has solved the transportation problem below ground and made it almost possible to do without horses or mules.

The transmission of power for all purposes below ground is an important matter and one which at the moment is showing the most interesting development. The manager has a choice of wire ropes, steam, compressed air, and electricity as a motive power. All have their votaries and under special conditions each one possesses some advantage. To generalize, it may be said that wire-rope transmission is cheaper than any other up to one mile; after that electricity takes the lead. Within that radius compressed air is capable of doing very good work, being safe, easy to apply, and helpful to the ventilation. On the other hand, it is at least 20 to 25 per cent. dearer to instal than electricity, the greatest feature of the latter being the facility with which it can be adapted to various uses, its high efficiency, and its greater safety in the absence of gas. Bulkiness of pipe connections is a constant source of danger and inconvenience which does not exist in the case of cables. On the other hand, the use of electricity is limited, and in fact determined, by the element of danger which pertains to it; and to overcome this is the task of the electrical engineer of the future. It is being used where there is no gas, but there is a growing indisposition to take the cables into the working face whenever gas has been seen. At present its greatest use is for hauling and pumping, as these operations can be carried on as a rule sufficiently far from the working faces, where the greatest danger exists.

On the score of safety the most important branch of a colliery manager's duties relates to the system of ventilation adopted, and its maintenance in first-class order. Ventilating furnaces may be regarded as a thing of the past, and the manager can confine his attention entirely to the subject of fan ventilation. Here, again, there is a wide choice ranging between high-speed and low-speed fans. The considerations which should guide him in the selection are the following: the size of air ways that can be maintained, the quantity of air required to be circulated, and the probable water gauge. In considering these points it is well to look to the future, and to bear in mind the possibilities of a greater development than may appear probable at present. At the same time, it is a mistake to put in a plant of very much greater capacity than is needed, because the efficiency is lowered if the speed is brought below a certain point, and there are instances in which it would be cheaper to instal a small plant in the first instance and to replace it with a larger one subsequently. It may be taken for granted that the best results are being obtained today from comparatively high-speed fans, that is, fans with periphery speed of 100 to 200 feet a second; and of these there are several makes of so nearly equal

merit that it would be invidious to particularize, beyond saying that the best known are the Walker, the Chandler, the Capell, and the Schiele. The feature of ventilation during late years has been the development of "splitting" the air current, a principle the judicious application of which is today the best test for an expert in ventilation.

The elucidation of the coal-dust theory and the study of explosives have contributed much to the importance of ventilation, which now has to be considered in connection with both. With reference to coal dust it may be positively ascertained that the presence of 1 to 2 per cent. of gas in a dry and dusty mine creates the possibility of an explosion, and is in every instance an imminent source of danger. When it is remembered that under normal conditions and in the absence of coal dust 5 to 7 per cent. is the dangerous mixture, it will be seen how greatly the situation is altered by the presence of coal dust. No perfectly satisfactory method of dealing with this agent has yet been discovered. Attempts are made to remove it, but this can only be done very partially. It may, and indeed must, be collected from the floor, and this becomes an urgent duty now that the danger of its presence is known; but it cannot be swept from the working places where it is generated every day, and where as a rule the gas also is to be found. Attempts to damp the coal dust have been attended with some degree of success, especially when salt is used in the water, and some of the deeper mines have installed a regular system of pipe lines, by means of which they can sprinkle almost every part of the mine. This is done most effectively in combination with compressed air which is introduced into the water pipes near the nozzle and forms an excellent spray.

The subject of blasting is of even greater importance and has led to endless controversy of late years. The danger of blown-out shots, and the lesser danger of firing gas in a crevice at the back of a shot hole when the blast is discharged, are the two features which have received most attention. In connection with this matter the manager who understands his business will be extremely cautious in the use of explosives of any kind, in a gaseous mine, and will keep a keen look-out for the development of mechanical appliances, which are probably destined to supersede blasting in coal mines at no very distant date. While some high-class explosives are safer than powder, they are only relatively, and not actually, safe, and none of them is so well adapted for the purpose from an economical standpoint. The average cost of blasting with high explosives as compared with ordinary powder is probably 50 per cent. higher, and the breakage of coal is much greater.

THE MANUFACTURE OF IRON AND STEEL IN CAPE BRETON

By P. T. McGrath.

England won and long held supremacy in steel-making, in spite of relatively inferior iron-ore resources, because of unsurpassed fuel supplies and a sound and magnificent commercial system. The younger industry in the United States, with the handicap of a later start and widely divided material resources, won the ascendancy by concentrated study of intensified production, mechanical applications, and labour-saving methods. Cheap transport almost neutralised the wide distances between ores, fuel, and furnaces. Now, when international interest is concentrated on the rivalry, a new competitor appears on the Canadian seaboard, with claims to greater natural advantages than either England or the United States can show, and a clear foundation upon which to build according to the most advanced and successful practice. If the comprehensive grasp of all the elements of steel manufacture can be obtained in this region naturally, the artificial combination of the Steel Trust can hardly monopolise the trade of the world. It is in this light that the situation at Cape Breton has an interest warranting attention.—THE EDITORS.

AN enterprise for which its promoters claim that it will enable them to dictate the price of iron and steel for all the world is now taking shape at Sydney, Cape Breton. It comprehends the establishment of a great smelting works, complete in every detail and of the most modern design; and provision has been made for its eventual rounding off by the addition of a plant for the building and engining of steel ships and the docking and repair of damaged ocean steamers.

The initiation of this enterprise must be a matter of no small moment to British and American ironmasters, for the many advantages it enjoys are certain to react upon the like industries in both these countries. As a competitor with them it must in a few years attain a prominent place, and so clear is its superiority in many instances that a second plant is being arranged for at North Sydney, a few miles away, and a third may be set up in the near future at the Gut of Canso, in the same region and where the conditions are almost similar.

The factors which have contributed to the project taking shape are: The existence of vast beds of coal and limestone in Cape Breton, the recent discovery of immense iron deposits in Newfoundland near by, the comparative nearness of Sydney to the markets of Europe, and the stimulus which Canada gives to iron production by a bounty granted on all iron and steel manufactured within the Dominion. The

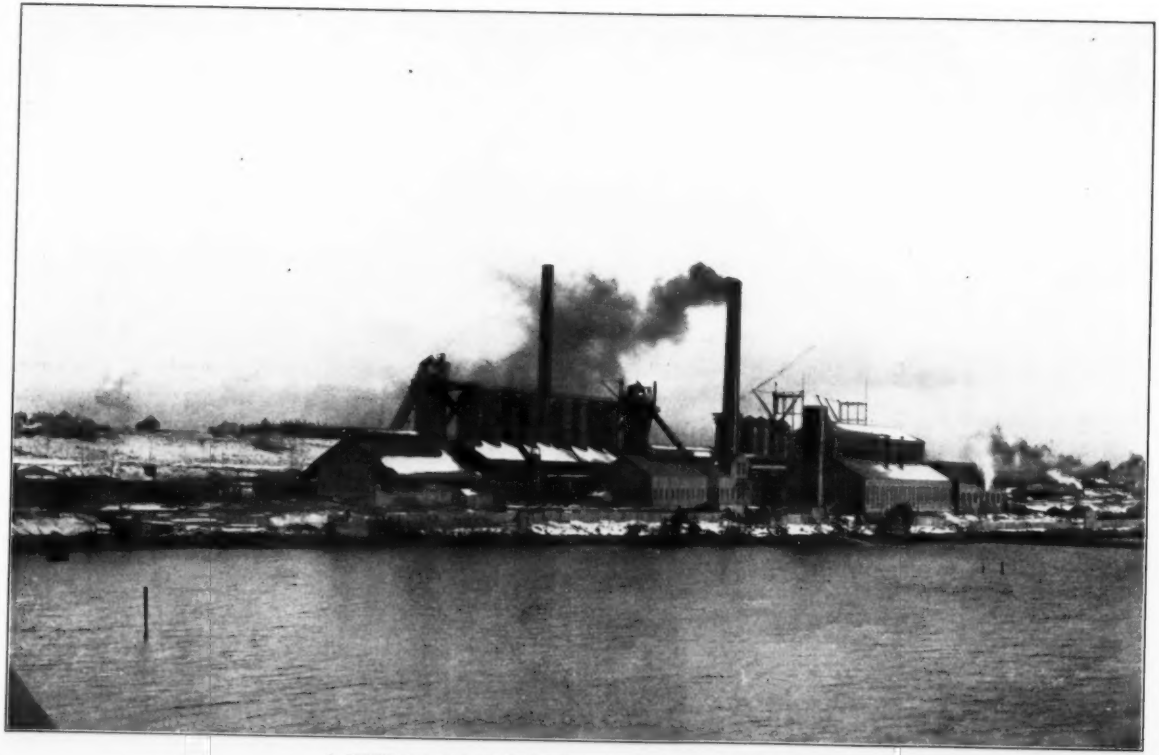
fact that Sydney lies right on the seaboard and that thereby extra handlings are avoided also formed a reason, and the steady advance in the prices of iron and steel during the past two years, with the apparent certainty of high rates being maintained, supplied the last argument required to transmute theory into action.

The inspiration for the venture came from Mr. Henry M. Whitney, a progressive American capitalist and a brother of the Hon. W. C. Whitney, who was Secretary of the Navy under President Cleveland.

When the recent boom in iron marked the world's industrial onrush, Mr. Whitney promptly grasped the significance of its bearing upon Sydney as the location of a great steel-making plant, and he soon enlisted the active co-operation of such prominent Canadian capitalists as Sir William Van Horne, president of the Canadian Pacific Railway; Mr. R. B. Angus, the retired manager of the Bank of Montreal, and Mr. R. G. Reid, the Newfoundland railway king. With these and others he formed the Dominion Iron and Steel Company, capitalizing at $20,000,000, with a charter from the Government of Canada and Mr. Whitney as presiding and directing genius.

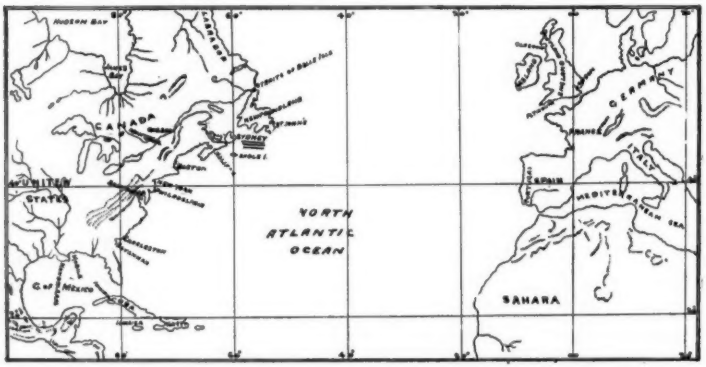
Sydney was selected as the site for the steel works because it was already the outlet for the coal trade, it was located in the centre of the coal and limestone region, and it possessed a tract of land near the water front eminently suited for the purpose in view. Sydney harbour is large, safe, and capacious. It has already become known to shipmasters as a coaling port and it is the half-way house to the Gulf of St. Lawrence. It is five miles long and the average depth of water is 50 feet. The entrance is wide and unobstructed, and the harbour is sheltered by the neighbouring uplands so that a fleet might swing at anchor there. Last summer seven British and three French war-ships lay there together, besides other shipping. It is the terminus of the Intercolonial Railway of Canada, by means of which connection is made with every part of the western continent; a railway 40 miles long and operated by the coal company connects with Louisburg, another shipping port; and it is a point of call for American and Canadian coast steamer lines.

These advantages, however, are trivial when compared with the superiority which its geographical position affords. It lies at the most easterly point of Cape Breton, and, excepting Newfoundland, is nearer to Europe than any other part of North America. From Sydney to Liverpool is but 2,282 miles, while from New York it is 3,110 miles and from Philadelphia 3,160 miles (these being the ports whence the Pittsburg and Chicago produce is shipped) to the Mersey. The com-



A GENERAL VIEW OF THE SYDNEY BLAST-FURNACE PLANT.

parison is even more detrimental to Mobile (4,506 miles) and New Orleans (4,553 miles) these being the outlets for the Alabama smelters. Sydney, therefore, enjoys the initial advantage of being almost 1,000 miles nearer the English market than New York and 2,200 miles nearer than New Orleans.

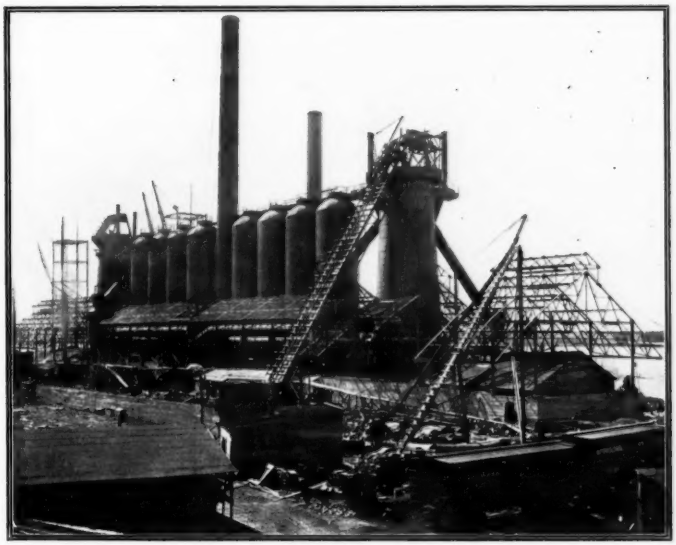


MAP SHOWING THE ADVANTAGEOUS GEOGRAPHICAL POSITION OF SYDNEY.

With regard to coal, the situation is as favourable. The coal areas held by the Dominion Company cover 200 square miles of productive measures, with several workable seams each several feet in thickness. The potential output is therefore almost appalling in its immensity. One of the directors has put it graphically by this formula: "We can produce 3,000,000 tons per annum for 1,000 years." Though the present output is equal to all existing demands, the inauguration of the steel works and the prospect of subsidiary industries necessitated provision for a largely increased production. A new shaft was accordingly sunk last year. Its capacity is 4,000 tons a day and there are 58,000,000 tons in sight, a supply for over fifty years. This is the greatest mining shaft on the western continent, by 1,000 tons a day. Nearly 1,100 men can work in it at once, its pit is 55 feet square, and it is to be the mainstay of the smelters. The shipping pier at Sydney has a daily capacity of 15,000 tons, and five steamers can load there at the same time, while the Louisburg pier can deal with 8,000 tons daily and three steamers at once. The line of railway between the two ports is operated by 120-ton locomotives, which have hauled 100 cars of 15 tons of coal each, though the average load is 900 tons.

The Sydney coal is bituminous. A series of experiments showed it to be admirably adapted for the purposes of smelting, and the prac-

tical tests confirmed this conclusion. It was found that it was only slightly higher in sulphur than the Connellsville coal, and that the excess could be economically washed out. But the plant started with the unwashed product, having the advantage of an unusually pure flux, which contributed not a little in controlling the sulphur. The second cast from the furnace assured this control and the fifth reduced it down to 0.019 per cent., which for most purposes is too low, rather than too high. The unwashed Sydney coal gives a coke with but 6½ to 7½ per cent. of ash as against 10½ to 11 per cent. in the Connellsville; while in fixed carbon Sydney gives 90½ to 91 per cent. as against 89½ in its competitor. In the letter of general manager Moxham to president Whitney, dated March 1st, 1901, which was published in connection with the recent flotation of Dominion Iron and Steel Company preferred stock, he says, in reference to the coal:



FURNACES AT SYDNEY DURING CONSTRUCTION.

"We are operating our bye-product ovens with unwashed coal, nevertheless the coke manufactured is of excellent physical quality. It is capable of hard driving and of maintaining the burden in the blast furnace without trouble. While slightly higher in sulphur—as must be the case until we wash it—our pure flux renders this no disadvantage to us. We have demonstrated that the question of washing is not

a necessity, but purely an economic question. The coke from washed coal will be fully equal to the celebrated Connellsville standard—the sulphur will be no higher, the ash lower and carbon higher."

All the coal and limestone required for the furtherance of the project are obtainable within a very short distance from Sydney and can be mined at a figure so low as to be thought incredible in other quarters, but the economic phases of the venture had been carefully studied and the cheapening in the cost of the marketable product as a result of this fortunate natural combination was not overlooked.

The acquisition, however, by the steel company, of the hematite iron deposit at Bell Island, Newfoundland, was the circumstance which above all others made the enterprise possible. This is the most remarkable mine of its kind in the world—an open quarry, as it were, of ore, accessible by merely stripping off a surface covering of rock and loosening the hematite strata by steam drills and dynamite charges. Bell Island lies in Conception Bay, about 35 miles by water from St. Johns, and 380 from Sydney. It is 8 miles long by 3 broad, and the hematite beds, five in number but only two commercially valuable, lie upon its northern shore. An expert authority states that the upper workable bed has an area of 240 acres and a thickness of 6 feet, which should yield 6,000,000 tons, at 6 cubic feet to the ton. The lower bed is

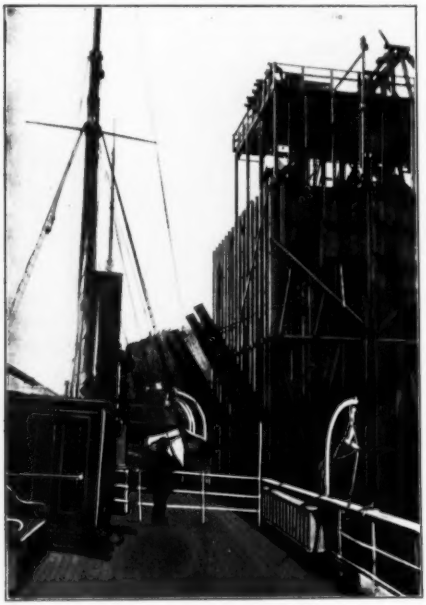
WORKINGS AT THE BELL ISLAND IRON MINES.

THE IRON MINE AT BELL ISLAND.

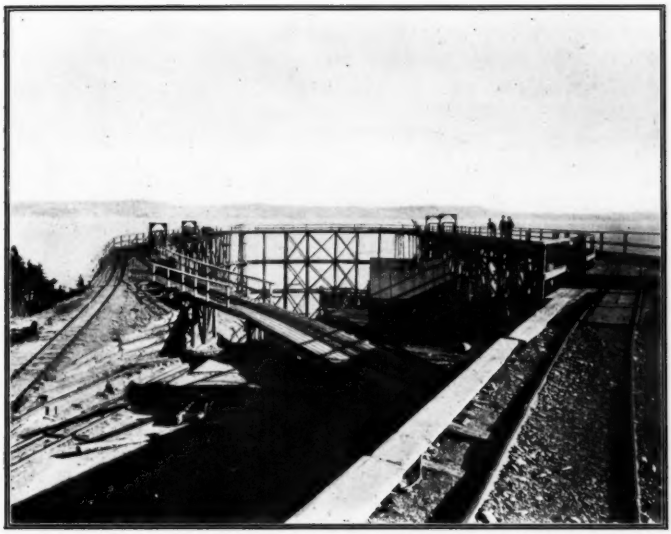
much larger—817 acres, and 8 feet thick, giving about 28,000,000 tons in sight. This bed, which dips downward at an angle of 8 degrees, extends out under the waters of the bay, and there is good ground for believing that when the ore now available is exhausted submarine workings may provide an additional supply the extent of which cannot be estimated. This deposit was discovered by some fishermen a few years ago, who brought some blocks of it to St. Johns as ballast for their boat, with only the vaguest ideas of its value. Its worth was realised there by some speculators to whom it was shown, and mining rights over the property were secured by them and the original finders. The Nova Scotia Steel Company purchased the property from these holders in 1897 for $120,000 and developed it considerably, uncovering and mining much of the ore, building a shipping pier at a suitable point on the east face of the island, and laying a tramway to connect the mine and the pier, by means of which they were enabled, during 1897, 1898, and 1899, to ship over 500,000 tons of ore, to their own works at Ferrona (Nova Scotia), Baltimore, Philadelphia, and Rotterdam, where they readily found a market for it.

Last summer the Dominion company purchased from the Nova Scotia corporation the larger bed, paying $1,000,000 for it, with the tramway, pier, and other appurtenances, the vendors retaining the upper bed for their own use. The ore in both is almost identical, containing about 55 per cent. of metallic iron; and along an outcrop of 3½

miles no dislocation of the strata has been found, the ore being exposed over most of its extent, thus giving unusual facilities for open-cut working, so that probably 4,000,000 tons can be got out by this means. No elaborate machinery is therefore necessary. The tramway is carried along to the face of the working, and shifted as this recedes. The cars run by gravity, a double-track line, two miles long, conveying them to the pier, the loaded cars going out on one set of rails and the empties returning on the other. The ore is in small rectangular cubes, a few inches each way, and millions of these are set together to form the deposit, in regular layers, one upon another, like a huge structure of small bricks. The upper surface of the strata seems an immense tiled floor. The deposit is veined through and through with these lines of cleavage, and, while the mass cannot be sundered except by charges of dynamite, the resultant explosion shatters a portion of the deposit into its millions of perfect rhomboidal fragments, which are shovelled by the workmen into the waiting ore cars, much as anthracite coal is handled. The cars grip onto an endless cable and at the pier are automatically upset, the contents falling into one of the ten pockets into which it is divided. Each pocket holds 200 tons, and the contents are discharged by gravity into a steamer's hold, ten minutes sufficing to empty a pocket. Behind the pier a reservoir has been excavated in the hillside, with a capacity of 20,000 tons, and from it an endless chain of small hoppers carries this ore along to the pier, the ship's loading being completed by the discharging of their contents into her hold after the pockets have been emptied. A 5,000-ton boat can be loaded in from 4



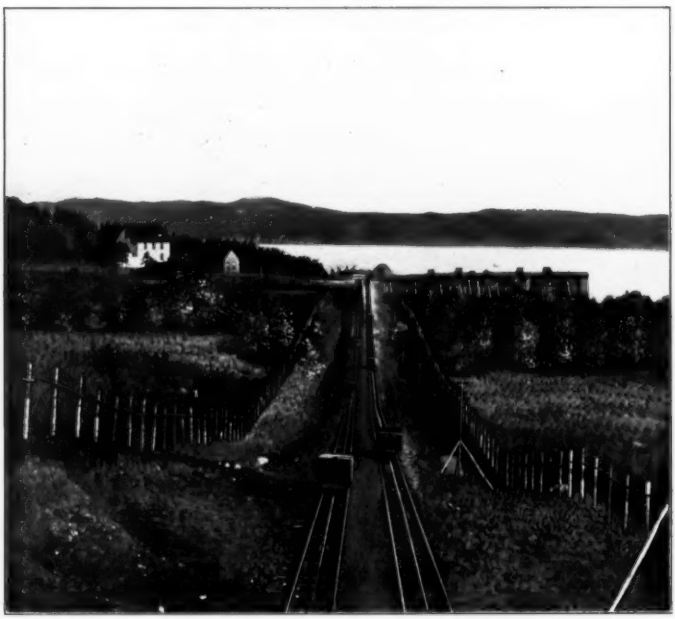
VESSEL LOADING AT THE ORE PIER AT BELL ISLAND, NEWFOUNDLAND.



LOOP AND AUTOMATIC DISCHARGE FOR TRAM CARS ABOVE THE ORE PIER.

THE BELL ISLAND PIER. LOOKING DOWN THE TRAMWAY.

THE ORE PIER AND TRESTLE APPROACH.



CABLE TRAMWAY FROM MINE TO PIER. FULL CARS DESCENDING AND EMPTIES COMING UP.

to 5 hours. The tramway has a capacity of hauling 3,000 tons to the pier in 10 hours, but this can be doubled by increasing the rolling stock. The depth of water at the pier is 24 feet, and a second one is now being built, which will enable the output to be duplicated, as the bay is closed by ice during four months of the year and a full supply must be obtained in the other eight months.

It has already been shown that coal and limestone are most favourably located as regards Sydney, being at its very back door, so to speak. The possession of the Bell Island mine enables the Dominion company to procure iron ore at a lower price, to manufacture it cheaper, and to sell the product for less, than anywhere else in the world and yet make as large profits as any competitor. The cost of mining this ore and loading it on shipboard has been proven by the Nova Scotia company, by three years' experience, to be 45 cents a ton. The freight to Sydney is another 45 cents. The unloading of it there costs about 10 cents. Allowing for increases in wages, for which the workmen are now agitating, and for other expenses, the ore can be fed to the blast furnaces in Sydney for not exceeding $1.25 a ton. The combination of advantages is unique. The ocean passage from Bell Island to Sydney occupies only 36 hours, and there is deep water the whole way, the largest ocean-going steamers being available for freighting the ore. There is but one handling, and no royalty is exacted.

Almost all the ore used in the United States comes from the great iron ranges of Minnesota, at the head of Lake Superior. This ore has to be brought by rail from the mines to the lakeside, then shipped on a whaleback and floated down through the canals to a port within easy access of the smelters, and there unloaded and railed again to the furnace mouth. Taking into account the several different portions of the country which absorb this ore it is correct to say that every ton of ore from Minnesota has to be handled three times, by rail, steamer, and rail again, and carried 800 miles from the pit to the smelter. It costs at least 50 to 80 cents a ton to mine it, nearly $1 to freight it by water, and 50 cents at least for the railroad carriage. Last year non-bessemer ores cost $2.50 a ton laid down in Pittsburg, and bessemer ores $3.25. The advantages in favour of Bell Island ore are thus very marked.

With coal the conditions are somewhat similar. Except the Pennsylvania furnaces, which have coal near at hand (but have to haul their iron ore extreme distances) all the other American smelters—save in Alabama—have to procure their coke supplies from centres 300 to 400 miles away, the railway carriage on this forming an important factor

in the cost of the manufactured product. The American furnaces are also handicapped by their remoteness from the seaboard. The Pittsburg output has to be hauled by rail to tidewater at New York or Boston, an average distance of 450 miles, at a cost of ½ cent a mile per ton, or $2.25. The Alabama iron, to reach the littoral at New Orleans, must be carried some 530 miles, at a cost of $2.65, the ocean voyage then being 4,500 miles.

Sydney, on the other hand, lies right on the seaboard, the several processes involved in the mining and manufacture of the iron are carried on more cheaply and conveniently than elsewhere, the product is transferred from the smelter beyond the wharfside to the ocean steamer lying at the pier-head without any intermediate carriage by rail or river, and the distance to Europe is 800 miles less than from New York and 2,200 less than from New Orleans.

It is true that the Bell Island ore is not as rich as that of the Lake Superior region; but it is a high-grade ore, it mixes readily with others, its ease of mining and transport and its abundance and accessibility do much to equalise its shortage in mineral, and it is far richer than some ores which have set the standard of production in the past. The leading ores may be thus compared:

Lake Superior ore	63 per cent.
Bell Island ore	55 per cent.
Cleveland (Eng.) ore	42 per cent.
Alabama ore	40 per cent.

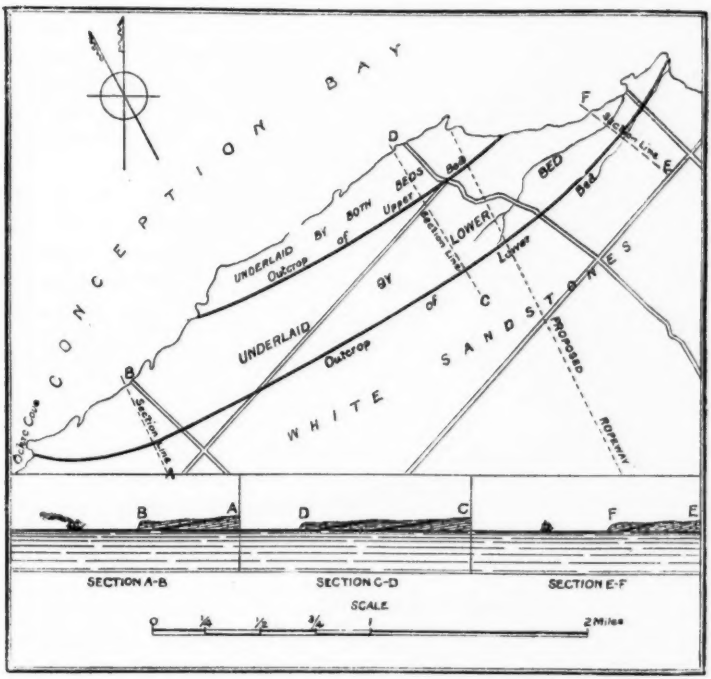
The cost of production also tells greatly in favour of Bell Island ore, and must make the Sydney output much sought after. The Nova Scotia Steel Company has been smelting it for three years and figures the cost as follows, the estimate for the iron being calculated on the basis of underground mining.

1.8 tons of ore	cost	$1.80
1.25 tons of coke	cost	1.80
.75 ton of limestone	cost	.40
Labour and incidentals		1.50
		$5.50

To convert this pig iron into steel billets involves an expenditure of $5 a ton more. And yet, last year the following prices ruled.

At Alabama, gray forge pig iron	$12.00
At Pittsburg, gray forge pig iron	19.00
At Pittsburg, Bessemer pig iron	22.00
At Pittsburg, Bessemer steel billets	37.00
At Pittsburg, open-hearth steel billets	42.00
At Glasgow, summerlie pig	21.00
At Glasgow, steel billets (warrants)	30.00

These prices, of course, were obtainable only during periods when a "boom" in iron prevailed, and could not be maintained if a reaction



MAP OF GREAT BELL ISLAND ORE DEPOSIT AND SECTIONS.

came. But at the prices just quoted for the cost of production at Sydney, plus $2.50 a ton freight to Europe, iron and steel from Sydney can be laid down in England at a handsome profit even in periods of depression. To land this pig iron in Liverpool would involve a total cost of $8.00 a ton and steel billets $13.00 a ton, and the average price at which these have sold in England the past ten years has been $14.60 for pig iron and $22.90 for steel billets.

The Sydney enterprise will also have the stimulus of the Canadian bounty to promote its development during its infant years. The enormous growth of the American iron output has been a source of bitter irritation to the Canadians for years past, the United States producing 160 times as much pig iron although having but 12 times the population. In the endeavour to remedy this condition of affairs the Dominion Government a few years ago provided a bounty to encourage the home production of iron and steel. But even after this the industry

languished, and in 1898 only 77,000 tons of pig-iron were manufactured in Canada, and of the ore used 58 per cent. came from the United States and earned a lesser bounty of $2 a ton, Canadian ore being granted $3. The bounties were to expire in 1902, and there was little prospect of their renewal, until the Whitney capitalists entered the field with their plans for a large up-to-date plant, to be located at Sydney and fed with Newfoundland ore.

This entailed a reconsideration of the bonus policy by the Canadian Government, for while naturally objecting to subsidise American ore there were many cogent reasons for stimulating the development of the sister colony of Newfoundland. It was accordingly decided to extend the bounties for another five years, gradually reducing them by a sliding scale until they were extinguished in 1907. The Dominion Company will earn quite a sum by these bounties during the period they are in operation. The yearly capacity of the blast furnaces will be 511,000 tons (1,400 tons a day) which, at $2 a ton, will yield $1,022,000. The steel mill is to produce 800 tons daily, or 292,000 tons per annum, which, at another $1.50 a ton, will amount to $438,000, a yearly total in bounties of $1,460,000, which will likely yield nearly $6,000,000 in all, during the seven years ere the bounties cease.

From a consideration of all these circumstances it will, therefore, be readily realised that there is much point in the declaration of a leading American expert in iron and steel production, to the effect that the Sydney works will be able to dispose of its output at a figure at least $3 a ton less than Pittsburg can, and that this will represent a loss of $7,500,000 a year to the Pittsburg manufacturers on the present output of that place, as they will have to reduce their prices to meet those of their new competitors. The organisation of the Sydney enterprise is in the hands of most capable men, every stage of its development has been carefully canvassed, the experience of the existing industries on both sides of the Atlantic can be profited by, and the plant will be all of the most modern and improved type, the men selected for the control of every phase of the undertaking being the best that money could procure in their respective professions, and all being animated by the desire to make this new venture one of world-wide repute.

The works are located on a large area of unoccupied land east of the town of Sydney, affording an ideal site for the purpose. It comprises 494 acres, with a waterfront of a mile and a quarter, and the municipality of Sydney purchased it for $83,000 and presented it to the company as an inducement to the selection of the town as the

home of the works. Ground was broken in June, 1899, and an army of men being employed, the transformation of this waste area into the seat of a mighty industrial enterprise is rapidly proceeding. The several divisions of the undertaking are well advanced. The complete plant is as follows:

Eight batteries, of 50 each, of coke-ovens, making 400 in all. These are on the Hoffman bye-product system, of the latest type, and designed for the saving and utilisation of all the bye-products of coal, which go to waste in nearly all the American smelters. The total capacity of these ovens will be 1,600 tons of coke daily. To produce a ton of coke will cost about 40 cents, but it will yield bye-products worth about 70 cents, of which the sulphate of ammonia will be sold as a fertiliser, the coal-tar will be disposed of for commercial purposes, and the illuminating gas will be used in the steel-making later.

Four blast furnaces, each of a capacity of 350 tons, or 1,400 tons in all. These are duplicates of the latest set up at Pittsburg, and admittedly the best in America. They are 85 feet high and 19 in diameter.

Ten 50-ton open-hearth steel furnaces will be set up for the manufacture of steel. Open-hearth steel is increasing in favour on the American continent to such an extent that it is felt that this quality will yield the best returns. The capacity of these furnaces will be about 1,100 tons a day, 400,000 tons per annum. The steel will be made from both the pigs and the hot metal. A rolling mill is also proposed, and piers, wharves, machine and repair shops, and other accessories will be provided as fully as the growth of the works demands.

The United Coke and Gas Company, of Pittsburg, Pa., are the contractors for the erection of the coke ovens. The Riter-Conley Company, of Pittsburg, U. S. A., have the contracts for both the blast furnaces and the steel mill. Their contract is all-embracing, and the figure is just $5,000,000, probably the largest single contract of the kind ever awarded. They will also provide 12,000 horse-power boilers, and five of the largest blowing engines ever constructed; six electric cranes and an electric plant for light and power. Their contract requires 13,000 tons of steel and iron work, and 15,000,000 bricks.

At the head of the steel company is Mr. H. M. Whitney. The vice president and general manager is Mr. A. J. Moxham, an Englishman who founded a large steel plant at Lorain, Ill. The consulting engineer, under whose supervision the whole plant is being established, is Mr. Julian Kennedy, who was consulting engineer at Carnegie's Pittsburg works, and who is among the highest authorities in the United States on such matters.

THE MACHINISTS' STRIKE IN THE UNITED STATES.

A SYMPOSIUM OF THE OPINIONS OF LEADING EMPLOYERS.

UNWELCOME as the admission is, it must be acknowledged that the strike of the machinists in the United States is sharp disappointment to the advocates of association and conference as a means of averting labour troubles. One year ago this month we published the "New York Agreement" between the National Metal Trades Association and the International Association of Machinists, an an example of the adjustment of labour troubles by common-sense agreement and arbitration between employers' and employees' organisations. True, we felt compelled even then to add that the millenium was not yet—that "the labour union, in its present form, is not a very responsible organisation, and shows a tendency to profit by its intangibility too often to establish a very strong feeling of confidence." It is distressing to find within twelve months that the fears, rather than the hopes, have been realised.

And yet this very distress embodies a germ of consolation. It was the neglect and abuse of the principles of organisation and conference, not reliance upon those principles, which precipitated the trouble. The most deplorable result of the difficulties would be abandonment of the policy of arbitration so promisingly inaugurated a year ago.

The general history of the trouble is widely known. It is recapitulated, with most generous allowance to the men's position, in Mr. Nelson's letter below. Briefly, it is that over a question of wages—heretofore mutually recognised as necessarily a matter for local adjustment—the men have attempted to force a general action by a general strike, thereby violating the fundamental agreement between the employers' and employees' organisations, which was that no strike or lockout should be declared pending discussion of points of difference, or until conference and arbitration had failed. The manufacturers therefore resolved that by officially refusing arbitration and

ordering strikes "the International Association of Machinists has wilfully violated its agreement of May 18th, 1900, and having made the same NULL and VOID, the agreement is no longer binding on the National Metal Trades Association." They have declined further dealings with an irresponsible union, taken firm ground for individual treaty with their men, and in conference at Chicago on May 29, adopted their widely quoted "bill of rights," since adopted in other cities.

The fact, however, that the initial question (of wages) is so essentially a local issue, has led to great diversity of individual action and attitude. With a view to giving a comprehensive review of the entire field, THE ENGINEERING MAGAZINE has invited expressions from a large number of representative firms in all parts of the United States. Their opinions, quoted below, will be found of the highest interest and value. Mr. Nelson, of the N. O. Nelson Manufacturing Co., of St. Louis—a concern widely noted as a pioneer in efforts to establish harmony between labour and its employers—is placed first as being most comprehensive in his review of the case. Mr. Nelson says:

"The machinists demand a 9-hour day with no reduction in the day wage. The associated manufacturers (by the New York agreement of May, 1900) agreed to a 54-hour week, effective May 20, 1901. The wages question was not mentioned; it was purposely omitted; it was considered a local question subject to various conditions, not subject to national action. Under this construction the machinists submitted local agreements covering wages and other matters. The employers' association in their April annual meeting decided unanimously that these agreements should not be signed, but should be referred to the general office and the unions so notified. * * *

"The association's committee said further that its members were prepared to arbitrate the wages question in each individual dispute and date the award back to May 20th, to which the union president objected that the wages question had never been made part of the argeement to arbitrate, that it was now too close to the date (nine days) when the change in hours and pay took effect, that the men could not be expected to work several months at reduced pay pending arbitration, that local arbitration in innumerable cases (practically all shops) would place the workmen at disadvantage with their more astute and resourceful employers, and, finally, that a strike would be ordered wherever the local members of the two associations failed to adjust."

The machinists' position, even thus fairly summarised, does not command assent. There was no codified list of matters which should be arbitrated, but a general agreement that every difference should be adjusted without stoppage of work—by conference if possible, if not, by arbitration—with no general resort to strike or lockout until all peaceful measures had failed. The employers offered to adjust an admittedly local matter by the accepted local instrumentalities; the

machinists rejected the agreement they had pledged themselves to accept, on grounds which are mere quibbles and not even plausible.

"The strike was ordered, union and non-union machinists co-operated, and so did association and non-association employers. Perhaps one-third of the capacity of the country made no opposition to the shorter day or week at the old pay; others settled at from 6 to 12 per cent. on the former hourly rate.

At a called meeting of the administrative council of employers, the agreement of a year previous was abrogated on the ground of violation by the union. In the meantime strikes and lockouts have practically closed the shops of Chicago, Milwaukee, Dayton, Cincinnati, and partially closed other cities. The employers' association has changed from arbitration and conciliation to defence.

"The principle of arbitration is apparently on trial, but in reality the disputants are only going through the kindergarten stage of industrial adjustment. They have yet to learn that chips on shoulders, lockouts, and strikes do not pay and settle nothing. What they cost is gone forever, and a sore spot remains. Also they must learn that arbitration is applicable to some questions and not to others. It is not applicable to general changes in hours and wages.

"A large portion of the employers of the United States believed in the shorter day and gave it cheerfully on or before May 20th. They knew that a reduction in daily wage in these prosperous times was not reasonable and would not be satisfactory, hence they continued the old day rate. To this number additions kept coming, partly from the pressure of business, partly from negotiations with their men, and partly from the conclusion that a 9-hour day of steady work is enough. Individually, a large majority of employers believe that the 9-hour day at the old pay is fair; those of them who object do so on the ground that it is not universal and would put them at a disadvantage. In fact, their advantage is to go peaceably on with their business, and should the movement fail, they can go back to the longer day with better grace than those who fought it out."

The belief in the eventual prevalence of a 9-hour day is indicated by some of our correspondents, in spite of the generally entertained view that it would be fatal to the ability of the United States manufacturer to compete in export markets. One concern in a city of the middle western States, which has stood almost alone locally in granting the men's demands, puts it thus:

"The most that we can say about the future prosperity of foreign trade with the United States is, that quite a per cent. of our business is foreign, and we did not hesitate to grant our men the increased pay and shorter hours as soon as the agitation became serious. Our men have not been out of the shop; we have not lost an hour's work, and we do not feel that the additional money we are paying the men will jeopardize our business in any way."

A large ship-building concern on the Atlantic coast puts it more qualifiedly:

"If this demand (10 hours' pay for 9 hours' work) could be met by simply granting the machinists' request, it possibly might be a matter for ship-building concerns to give consideration; but it would be simply an opening by which they would then on the request of 120 men have to raise the wages of 2,000,

making a reduction of 10 per cent. in their output and an increase of 10 per cent. in their wages. This, taking everything into consideration—piece work, etc.—would mean an increase of between 7 per cent. and 8 per cent. per year. This, under the circumstances and the long-time contracts ahead, taken on 10 hours a day and pay basis, would be impossible for any ship-building firm to accede to.

"We are of the opinion that nine hours will be a day's work eventually, but it will come by the process of evolution and not that of revolution. If this thing continues to spread, which we doubt, the result would probably be as disastrous here, in our opinion, as have been the results of the trade unions in England.

In general, even more clearly than in the instance above, the replies are indicative of the recent rapid growth in the business aims and market aspirations of the United States manufacturer. He measures local conditions by their influence on his competitive position abroad, or by their tendency read in the light of British or Continental experience. The former point of view is adopted by Mr. Walter Wood, of R. D. Wood & Co., of Philadelphia:

"The question seems to me to be how many hours can men comfortably work? Whatever this may be, there will be somewhere in the world earnest and active men who will stand ready to work that many hours and they will be those who succeed in securing trade in the long run from their fellows.

"Referring to the present situation I should feel that it was a mistake for the good hearty men of the United States not to be willing to work ten hours and to put in their pockets the money that comes from ten hours' labor, and enable the manufacturer with whom they work to be in better position to secure the trade of the world, for which, sooner or later, every one will be striving when dull times come around. Hence I would sincerely regret to see this country do anything that would weaken the lead it has already secured."

Another large house, internationally known as makers of machine tools and located in the same section of the United States, put it thus:

"We believe that the effect of the present wage struggle on foreign trade will be to greatly decrease, if not entirely prevent, any exportation of machine tools such as we manufacture. We should think that it would have the same effect on all tool builders; that is, supposing that the machinists gain their fight for the shorter working hour at the higher rate of wages. The cutting out of foreign business will seriously affect prices in the home market unless the cost of labor is reduced promptly to the old level."

A Cincinnati manufacturer, largely interested in the export of machine tools, says:

"The strike undoubtedly is affecting adversely the domestic market, and as a settlement of the strike will undoubtedly mean an increase in the cost of manufacture, it will also affect adversely the foreign trade."

But a graver note is sounded in the following communications, which we are permitted to quote over the writers' signatures. It is a forecast of the more paralysing encroachments of that unwise trade-unionism which has been Britain's bane. They are as follows:

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., JUNE 4, 1901.

Editor of THE ENGINEERING MAGAZINE. *Sir*:—

"We think we are all agreed here at present that the exact stake at issue is to unionize all the shops in the United States. That is only a prelude to the unions' undertaking later on the management of the machine business. The effect of that can easily be seen by studying the situation in Great Britain. It will cripple the domestic demand for machinery and make it harder to compete with foreign countries on account of the excessive cost. The struggle in the spring of 1900 had the same thing in view that they have now."

Very Truly Yours, R. VIALL, SUPT.

THE LODGE & SHIPLEY MACHINE TOOL CO.

CINCINNATI, O., U. S. A., JUNE 3, 1901.

Editor of THE ENGINEERING MAGAZINE. *Sir*:—

From our point of view, the issue is the breaking of the perfectly explicit written contract and the determination of the organizers of the union to unionize the machine shops of the United States. We believe that the talk of increased pay and shorter hours is merely dust for the eyes of the manufacturers and that the cry of increased pay and shortened time is necessary for the leaders to carry the men with them to accomplish their purpose."

Very Truly Yours, THE LODGE & SHIPLEY MACHINE-TOOL CO.

We can perhaps best sum up the position of the farthest-seeing American manufacturers in the words of Mr. H. W. Hoyt, of the Allis-Chalmers Company, Chicago, whose fair and liberal discussion of the labour-question in our issue of May, 1900, will be recalled with pleasure by our readers. Mr. Hoyt says:

"From my point of view, the conditions existing are directly traceable to a broken agreement, solemnly entered into between the National Metal Trades Association and the International Association of Machinists in May, 1900. The writer of this letter was one of the earliest advocates of arbitration and conciliation, and took a very earnest effort in starting the negotiations here in the city of Chicago which resulted in the New York agreement, above referred to. The abrogation of that agreement within a year has not only been a serious disappointment, but augurs badly for the future. In connection with the growing limitations placed upon shop output and increasing interference with shop management, I can see, if this programme continues, that American supremacy in the manufacuring world will soon be a thing of the past.

"I had supposed that the relations between the manufacturers and machinists had been placed upon a business basis. This hope I have at present abandoned, but I am not prepared to believe that eventually some national plan of adjusting difficulties will not be restored."

As we go to press, the situation is growing worse, rather than better. A bitter struggle is presaged—but possibly a short one, as the machinists' financial position is weak and the employers' moral position strong. Altogether it is a deplorable display of trade-union follies, in melancholy contrast to the exhibition of the potential good of organisation made last year.

EDITORIAL COMMENT

Several months ago (March, 1901) there appeared in THE ENGINEERING MAGAZINE a paper by Mr. Charles Rous Marten discussing the performance of American locomotives on British railways, and this is recalled by the remarks of Sir Alfred Hickman recently in Parliament, criticising the purchase of American locomotives for Indian railways, as well as the placing of orders for structural work with American firms. So far as the locomotive question is concerned, Sir Alfred tells us nothing more than Mr. Rous-Marten has already said; in fact, he does not tell us so much. The American locomotives in India are charged with requiring more repairs and consuming a greater quantity of fuel than English engines, and this, Mr. Rous-Marten told us several months before, was said of the American locomotives in England. At the same time he called attention to the indefinite character of these reports, and emphasised the difficulty of obtaining anything like a true idea of the coal consumption of either English or American-built engines, while Lord George Hamilton, in answer to Sir Alfred Hickman, says, speaking of the American engines in India: "the earliest reports were unfavourable, but when their working was better understood, and alterations were made so as to suit the local fuel, a marked improvement was noticed, so much so that one company wishes to obtain more engines of similar construction."

With regard to the Gokteik Viaduct, upon which it is charged that defective rivetting has been permitted, Lord George Hamilton says: "A most searching inquiry and inspection, made by the chief engineers of the Burma Railway Company, assisted by the Government's inspector, has satisfied the Railway Board that the work upon the bridge is sound and reliable."

Something more earnest than superficial criticism of allotted contracts is necessary, if the question of the loss of orders to British firms is to be satisfactorily answered. Lord George Hamilton is much closer to the mark when he says: "The competition we have to meet is founded on something more formidable and substantial than misunderstandings. Chemical research, concentration of capital, thorough technical education, improved industrial organisation, have made in recent years greater advance in America than here; it is with the product of these combinations and not with the assumed stupidity of Indian officials that the British engineer has to contend."

* * *

Mr. Morgan, magnified and multiplied by the fevered brains of sensation mongers and sensation seekers, is as multiform and as horridly ubiquitous as the Spanish fleet off the New England coast in the summer of 1898. He is seen simultaneously rushing east and dashing west, the smoke of omnivorous consumption trailing behind him and the bone of the world's trade in his teeth. The cartoonist shows John Bull nailing down his islands by their corners; the New York papers pretend that the Court is in fear lest the financier, taking a fancy to Windsor, should buy it off-hand; but it remains for the London *Express* to find the most fearful mare's nest of all, with a wild brood of nightmares, incubi, hippogriffs and chimeras just hatching out.

"An engineer of international distinction" has travelled the Continent in Mr. Morgan's service, buying navigable waterways, rights, franchises, inventions, patents, and systems of propulsion. All that is worth anything in the canals of Germany, Belgium, and Holland he has ac-

quired. Apparently, also, he has bought the Prussian Diet, the Kaiser, and the Russian Government, and set them at work extending the canal system in his interest. Meantime he has not been idle at home. The Erie Canal and the monopoly of electric canal-traction have been gobbled. Niagara, from shore to shore, has fallen into his hands. He has effected a Siamese junction with Vanderbilt; together they own Depew and Platt, Depew and Platt own the Senate, the Senate owns the United States, and all legislation and subsidies are Morgan's. He has not bought the ocean as yet—at least the narrator forgets to mention it; but with American canals, subsidised steamships, and Continental waterways all knit in his firm grasp, he is going to send his steel "far into the heart of Europe by water solely. Cargoes will be carried from mill to buyer without a break in bulk or a penny's expense for railway charges." We quote the *Express* accurately in summarising this marvellous scheme.

Marvellous is indeed a wholly insufficient term for the craft which float through the dream of the seer of the *Express*. Versatile, amphibious, behold them starting from Pittsburg straight overland two hundred odd miles, to get into the Erie Canal at all; floating down its seven-foot channel through the Hudson to salt water; putting fearlessly out to sea (supported by a subsidy); and finally entering and ascending the Continental canals, which have a limiting depth of 2.2 metres! With what pride of power would they make light of the rugged climb across the ridges of the Pennsylvania hills, usually so inconvenient for marine craft! With what sleek satisfaction would they contemplate their elastic build, adapted to the small locks, the shallow draught, and the low bridges of the canal, yet stable in the storms of the Atlantic! With what proud satisfaction would they discharge their cargo at the buyer's door, unbroken in bulk since it left the Pittsburg mill! With what thirst load again at the brewery with Münchener or Pilsener for a profit-bringing cargo on the long journey by canal, sea, and dusty roadway, home! Truly, of all Mr. Morgan's gigantic schemes, the *Express* has unearthed the most marvellous!

* * *

A striking example of what has been termed the "scrapping" of costly machinery while yet in perfect condition is seen in the recent transformation of the tramways in New York from cable to electric traction. It is estimated that the Broadway, Columbus Avenue, and Lexington Avenue cable plants cost $16,000,000. Of this amount about $10,000,000, represented by tracks and real estate, is still available, the remaining $6,000,000, through no fault of its own, having been doomed to the scrap heap simply because it has been superseded by more efficient appliances. In the case of the Third Avenue line, in the same city, recently transformed from cable to electric traction, there was a similar scrapping of property valued at $8,000,000. so that the total extent to which the Metropolitan railway system of New York has carried out this idea is represented by the sum of $14,000,000.

This is probably the largest example of the application of the modern method of prompt depreciation which has yet occurred and as a lesson to manufacturers it is full of meaning.

How best to provide for this supercession which takes the place of what was formerly termed depreciation, is a serious question. The establishment which adds to its factory costs a depreciation charge sufficiently high to sink the cost of the machinery in the time during which it can probably be profitably worked, may find the apparent profits seriously diminished, or the prices forced up to an impracticable extent. On the other hand, the manufacturer who does not thus provide for his depreciating plant, is really in a "fool's paradise," drawing dividends out of his principal while fondly imagining that they have been earned. It is a problem which many a works manager has to face, and those who have not the courage to meet it boldly, may find it all the more difficult to meet because it has been postponed.

REVIEW OF THE BRITISH PRESS

American and British Rolling-Mill Practice.

THE conspicuous feature at the recent meeting of the Iron and Steel Institute was undoubtedly the paper of Mr. William Garrett, comparing the practice of England and America in the operation of rolling mills. The paper was a strong arraignment of British practices, endeavoring to show the cause for the superior economy and increased output of American mills, and it naturally drew forth many replies and provoked an active discussion.

Mr. Garrett, although British by birth, is American by adoption and experience, while at the same time thoroughly familiar with British practice, and hence altogether in a position to know what he is talking about, and this, as well as the nature of his subject doubtless had much to do with the attention which his paper excited. Taking up in succession the topics of blooming mills, rail mills, tin plate bar mills, mills for structural steel, for merchant iron and steel, hoop mills, and wire-rod mills, he proceeded to compare the practice of America and Great Britain. Starting with the statement that the supremacy of Great Britain in the iron and steel trade has been lost, and that large quantities of foreign raw and finished material are being imported, Mr. Garrett assumed that something must be wrong with the British method of making Bessemer steel ingot, and rolling it into billets.

Comparing the practice of Great Britain and America in the matter of blooming mills, it appears that there is a decided advantage in making 4-inch billets, as in the United States, over the smaller sizes common in British practice, it costing practically as much in labor and establishment charges to make a 2-inch as it does to make a 4-inch billet. There is also a great advantage in the American system of keeping an exceedingly close watch upon every minute of time and the care which is taken to keep the mill continually full of material.

Taking up the question of rails, Mr. Garrett thinks that although the reversing mill is the best for billets, the three-high mill is superior for rails. The principal reason why British mills do not give so high an output as American mills is again due to the manner in which they are run. In America the rail mill is kept full of steel from six in the morning until six at night; with two bars in the roughing and two bars in the finishing at the same time, and if similar activity cannot be maintained in England the maximum production cannot be expected.

In no class of material has the loss of work to Great Britain been more marked than in tin plate bars. Prior to 1892 there was a demand in America for about 350,000 tons of tin plate per annum, calling for about 550,000 tons of tin plate bars every year, this being about 75 per cent. of the total British output. Nearly all the trade in bars involved in this has been lost, and tin plate bars of American make are being pushed right into British tin plate districts in 1,000 ton lots. This is entirely the result of the use of specially designed machinery, in which all the work, from the ingot to the finished bar placed on the cars, is done by machinery.

The methods of production of structural steel are so nearly alike in both countries that there is occasion for little notice, the work being about fairly divided between the three-high mill and two-high reversing mills.

In the case of merchant iron mills, the absence of competition, and the presence of plenty of orders has caused equipment to fall behind the times in England. Mr. Garrett made the astonishing assertion that during the past ten years all of the British iron and steel manufacturers together did not spend as much money on improvements as the Carnegie Steel Company did in two years. This in spite of the fact that nearly all great ideas which led to improvement

came from England. The Bessemer, the Siemens, and the basic processes all came from England. It is to Bedson that the continuous mill is due, to Allen, the heating furnace for billets, to Ramsbottom, the reversing mill, all of them Englishmen. In merchant steel no mills especially adapted to the work have been built in Great Britain, while in America great attention has been paid to this. Merchant mills with continuous trains, using the Allen furnace with Laughlin dropping-out arrangement, are producing as high as 445 gross tons of 1⅛ finished square bars in 24 hours, requiring only four men, and such mills have produced more than 8,000 tons in a single month.

The rolling of hoop iron has been carried to a high degree of perfection in the United States, and Mr. Garrett says that he considers the continuous hoop mill at Youngstown, Ohio, designed and built by the Morgan Construction Company, to be the finest rolling mill machinery in the world. This mill, which owes many of its distinctive features to a Welsh engineer, Mr. Edwards, takes a 1½-inch billet, 30 feet long, weighing 225 pounds in at the first train, and delivers it as 20 gauge hoop, ⅞-inch wide, coiled as neat as a ribbon, the only manual labor being that of a boy who takes the first end with a pair of tongs and enters it into the reel.

As to rod mills, it is only neces ary to mention the continuous rod mill designed by Mr. Daniels, which starts with a 4-inch billet and has an output of about 350 tons to the double turn.

Taking the rod mill as a basis for comparison, Mr. Garrett asserts that the four best rod mills in Great Britain, during the month of January, did not produce as much as one of the wire rod mills in the United States, which, during that month, produced 10,230 gross tons of No. 5 rods. Taking five British mills to equal this American output, a comparison of wages shows that the labor cost was 75 per cent. less for the American product than for the British.

This is but one of a number of comparisons which might be made, but it is significant, and is the warrant which Mr. Garrett gives for his conclusion.

"If the British iron and steel makers do not follow the example of their American cousins and combine, and then only manufacture their respective material at the most advantageous points for shipment, and use the most economical methods in manufacturing, the manufacture of iron and steel will, in time, become a lost art in Great Britain."

While the discussion elicited by this trenchant paper did somewhat to modify details advanced, the main principles remained untouched. Indeed, the whole trend of the discussion appeared to be defensive; hardly the proper manner to examine a subject by no means intended as an attack. It is only by such presentations of the facts relating to competition that that competition can be met, and the opportunity of obtaining the full account of the methods of rivals as given by Mr. Garrett is one which is rarely met, and in most instances would be eagerly welcomed, and promptly heeded.

The Proportions of Multiple-Cylinder Engines.

In a paper recently read before the Civil and Mechanical Engineers Society, Mr. Alfred Hanssen discussed the mooted question of the proportions of cylinders for multiple-expansion steam engines, and brought out some points of practical value to the designer. The questions involved in successful design of such engines is the attainment of the highest possible steam economy, together with an equal distribution of the power between the several cylinders. The equal distribution of the work is of most importance in cases where each cylinder is connected to a separate crank, and where the load is constant. The attainment of steam economy is always desirable, but depends upon several factors, of which cylinder proportion is but one.

Before considering the best proportions for the cylinders, it is therefore important to see that other conditions affecting economy have been provided for in the best manner. Tests of multiple expansion engines of good proportions, but which have not shown the steam economy which might have been expected, have revealed the fact that the presence of water in the cylinder was the principal cause of the large steam consumption. This presence of water may be due to priming, to cylinder condensation caused

by radiation, and to the defective drainage of the cylinders. Priming must be remedied at the boiler, radiation can be greatly minimised by ample use of heat-insulating lagging, while drainage is largely a mechanical problem. Professor Perry has pointed out that steam of 100 pounds pressure per square inch condensed in the steam cylinder and drained off before it has had time to re-evaporate, will impart 1054 thermal units per pound of steam to the cylinder walls, but if this water is re-evaporated during the exhaust stroke as a temperature of 142° F., only 60 units will be imparted to the cylinder walls.

The maximum amount of work can be obtained with the least expenditure of heat when dry steam is expanded without gaining or losing heat from the cylinder walls. The volume of steam in this case increases, not as in isothermal expansion, nearly inversely as the pressure, but inversely as the 0.88th power of the pressure.

With large engines at high piston speed the adiabatic expansion curve may be closely approximated in practice, and hence this may well be taken in determining the cylinder proportions. By constructing the curve for the pressure and total expansion ratio and then dividing this diagram vertically into parts corresponding to the number of cylinders to be used, the cylinders being taken in geometrical progression; also dividing the diagram horizontally into four parts each representing the initial pressure in the corresponding cylinder, rectangles are obtained. These rectangles are of equal areas and each contains an indicator diagram of nearly equal area, and from these diagrams the cut-off, drop, and other particular can be easily measured, and the valve gear adjusted accordingly.

Mr. Hanssen gives a practical example of the method as applied to a quadruple expansion engine, showing its convenience in actual design.

Syntonic Wireless Telegraphy.

In the March issue of THE ENGINEERING MAGAZINE, a review was given in these columns of the method and apparatus devised by Professor Slaby, of Berlin, for the purpose of rendering messages sent by magnetic waves over space, non-receivable by any except those for whom they are intended. This has been followed by a paper by Signor Marconi, read before the Society of Arts on May 15, and published in the *Journal* of the society, with diagrams showing how he had already solved the problem, and indicating the methods employed by him.

Mr. Marconi explained his silence as to his work in this direction by calling attention to the fact that business conditions required caution in making public devices which were in process of patent protection, but the dates of his experimental work and of his patents appear to bear out very conclusively the manner in which he has anticipated Dr. Slaby in obtaining multiple space telegraphy.

Without going too deeply into the constructive details of the apparatus by which messages may be sent from one transmitter to its corresponding receiver without affecting other receivers or being affected by other transmitters, it will be practicable to explain the principle upon which the method is based. In the early forms of transmitter electrical waves are radiated from a simple straight rod in which electrical oscillations are set up. These oscillations, however, die away with great rapidity, ceasing, not necessarily by resistance, but by electric radiation removing the energy in the form of electric waves.

Now, if a receiver is tuned to respond to electrical impulses of a certain period, the oscillator by which such a receiver is to be affected must be persistent in the periodicity of its impulses, just as a heavy pendulum, to be set in motion by small impulses, must receive those impulses at intervals timed to the period of oscillation of the pendulum. As Dr. Fleming remarked, a cork, floating on water will be bobbed up and down by any wave, long or short, but a heavy log of wood floating on the water and tethered to the bottom of the sea by a spiral spring would only be caused to bob up and down by waves having one particular period.

Mr. Marconi described, with the aid of numerous diagrams, his successive steps toward the development of a form of transmitter adapted to the emission of waves of constant or tuned periodicity, several successful forms having been produced. The tuning of the oscillation transformers on the

receivers was effected by winding them with varying lengths of wire in their secondary circuits, thus causing them to be in tune or resonance with the length of waves of any selected transmitted oscillations. This being done it was possible to obtain selection of messages with the ordinary transmitter when using two or three transmitters having wires of considerably different lengths; but this is only a very incomplete solution of the general problem. It was therefore necessary to increase the capacity of the radiating system, and this was accomplished, in one form of the apparatus, by placing near the ordinary vertical radiator, an earthed conductor, this increasing its capacity without increasing its radiative power. This was then improved by making the radiating and resonating conductors take the form of a cylinder, the earthed conductor being placed inside, and a great increase in efficiency followed this arrangement. In this form, Mr. Marconi presumes that it is essential that there should be a difference in phase of the oscillations of the two conductors, as otherwise their mutual effect would be to neutralize each other.

By using similar conductors in connection with both radiating and resonating instruments it is possible to cause the electrical period of oscillation of the receiving cylinder to correspond to that of one out of several transmitting stations, from which one alone it will receive signals. The closely adjacent plates and large capacity of receiver cause it to be a resonator possessing a very decided period of its own, no longer apt to respond to frequencies which differ from its own particular period of electrical oscillation, nor to be interfered with by stray waves, which are sometimes probably caused by atmospheric disturbances, and which occasionally prove troublesome during summer. Another advantage possessed by such cylinders is the very moderate height required, compared with that formerly demanded by the simple conductors.

Another variety of transmitter has been constructed by associating with the radiator wire a condenser circuit, this forming an oscillator which sets up very persistent oscillations in the transmitting vertical wire.

Still another form employs a circuit including a condenser together with the primary of a Tesla coil, the secondary of which is connected to the earth or aerial conductor. With this is used a receiver tuned to the frequency of the oscillations set up in the vertical wire by the condenser circuit. In this form it is essential to tune to the same period of oscillation the two electrical circuits of the transmitting arrangement, these circuits being the circuit consisting of the condenser and primary of the Tesla coil or transformer, and the aerial conductor and secondary of the transformer. The receiver consists of a vertical conductor connected to earth through the primary of a transformer, the secondary circuit of which is joined to the coherer. An adjustable condenser is placed across the coherer, increasing the capacity of the secondary resonating circuit of the transformer. In the case of a large series of comparatively feeble, but properly timed oscillations being received, their effect is summed up until the electromotive force at the terminals is sufficient to break down its insulation and cause a signal to be recorded.

Mr. Marconi goes somewhat into detail as to the windings and lengths of vertical conductors required to effect proper tuning, but for this and for the numerous diagrams the original paper must be consulted. It may be mentioned, however, that the length of the vertical conductor has been greatly diminished as compared with that formerly required, and on a portable apparatus installed on a steam motor car it has been found that a cylinder about 20 feet high, which can be lowered when traveling, enables signals to be communicated to stations more than 30 miles distant.

It is intended to provide the syntonic system in all future installations of space telegraphy, for, as Mr. Marconi remarked, "The ether about the English Channel has become very lively, and a non-tuned receiver keeps picking up messages or parts of messages from various sources which very often render unreadable the message one is trying to receive."

In commenting on Mr. Marconi's paper Professor Ayrton said that we were gradually coming within thinkable distance of the realization of a prophecy he had ventured to make four years before, of a time when if a person wanted to call to a friend he knew not where, he would call in a

very loud, electro-magnetic voice, heard by him who had the electro-magnetic ear, silent to him who had it not, "Where are you?" he would say. A small reply would come: "I am at the bottom of a coal mine, or crossing the Andes, or in the middle of the Pacific." Or, perhaps, in spite of all the calling, no reply would come, and the person would then know that his friend was dead. Think of what this would mean, of the calling which goes on every day from room to room of a house, and then think of that calling extending from pole to pole, not a noisy babble, but a call audible to him who wants to hear and absolutely silent to all others. It would be almost like dreamland and ghostland, not the ghostland cultivated by a heated imagination, but a real communication from a distance based on true physical laws!"

The Present Position of the Mechanical Engineer.

In the course of his Presidential address recently delivered before the Institution of Mechanical Engineers Mr. William H. Maw touched upon many points of importance bearing upon the present practice of mechanical engineering, and although it is impossible here to cover the entire field, some abstracts may be given.

The extent to which mechanical engineering enters into our daily lives is most inadequately appreciated by the average citizen. As a matter of fact there is scarcely a moment during which we are not indebted to the mechanical engineer for our necessities and comforts. Clothing, food, sanitation, transport, all are included in the immediate scope of mechanical engineering, while if more remote connection be considered the list might be almost indefinitely enlarged.

Touching briefly upon the question of technical education Mr. Maw considers the connection between the preparatory school and the technical college as a kind of cross-over road, in which the transition from the line of scholastic training to that of independent thought and action should be effected as smoothly as possible.

"Nothing is more disheartening to a student than to find at some stage in his career that he has been devoting time to learning things which are not only useless to him, but which it is really desirable that he should un-learn; while, on the other hand, he has failed to acquire knowledge of which he stands badly in need. Yet this is a far too frequent experience with boys entering technical colleges from our public schools. Matters are improving in this respect, and many of our large schools are conducted on less hard-and-fast lines than formerly, and are thus materially aiding the technical colleges in the early stages of their work. The changes, however, which have so far been made in this direction are of a very limited extent compared with those really acquired, and there is still left to be done at the technical college much educational work which ought to have been done at school, the result being a waste of valuable time. This matter is one which merits the most careful attention of all interested in technical education."

A still more important point in the career of the engineer is the junction between the college training and the future professional career. Here the technical college should be so conducted as to connect with the practice of the engineering establishment, as it is hardly to be expected that the latter will modify itself to suit the methods of the college. The principal defect of the technical college in this respect is found in the predominance which is given to a certain limited field of work, thus preparing men for lines already overcrowded.

"For some branches of our work, our colleges as they exist, afford an admirable training. Thus, the principles of steam-engine construction and working are usually very fully taught, and the student is rendered familiar with modes of testing both materials and motors, and other kindred matters. The result is that a student, entering works where steam engines are built, at once feels more or less at home; and he acquires a knowledge of shop work much more quickly and easily than he would have done had he not had his previous college experience. But the young engineer who enters some less-known branch—say, for instance, the construction of ordnance, of textile or milling machinery, or even of machine tools, such as are used in advanced practice—finds himself on far less familiar ground, and greatly in want of preliminary special training. In fact, he feels himself

in the position already referred to as so undesirable—namely, that he has spent time acquiring knowledge which is of little immediate practical use to him, and that he has done this at the expense of not learning things which he badly wants to know. Of course, it is quite impossible for the educational equipment of our technical colleges to comprise plant relating to more than a very restricted number of branches of mechanical engineering work, while the knowledge of a staff of professors and the variety of the training they are capable of imparting are necessarily finite; but, notwithstanding this, it will be found possible to do much more than is now generally done to give a special character to the final stages of a college course, and to encourage students to take a wider view than most of them now do of the possibilities of the career upon which they are entering."

"It cannot be too thoroughly appreciated that the vast development of mechanical engineering work which has been going on in the past half-century, and which is still going on at an ever-increasing rate, is producing a most important change in the conditions which secure both professional and commercial success. In the old days, our leading firms of mechanical engineers had comparatively few customers; and they had, as a rule, to meet the great variety of requirements of those customers to the best of their ability. Repetition work was comparatively rare, and success depended largely on resourcefulness and the power of entering thoroughly into the conditions to be fulfilled. Nowadays, the successful mechanical engineer is not he who makes a great variety of things for the few, but a small variety of things for the many; at the same time producing those few things in the most perfect way. Such a manufacturer will not be confined to his own country for the sale of the machinery he produces, but will be able to supply the markets of the world."

The development of transport and of communication unite to enable us to draw supplies from all countries, and also accelerate to opening up of new countries as customers for engineering products. These influences, acting as they do for all countries, have greatly increased competition, and as a result of this competition methods must be modified and changed from those which obtained under earlier conditions.

Mr. Maw proceeded to discuss at length much of the work of the mechanical engineer in connection with standardising, testing, research work and specialisation, and emphasised the advantages accruing to all by such institutions as that over which he had been chosen to preside, and the whole address forms most timely and profitable reading.

The Boiler Committee's Report.

THERE appears in a recent issue of *Engineering* a communication from the Marquis de Chasseloup Laubat commenting upon the interim report of the water-tube boiler committee in a very interesting manner, and in view of the extensive theoretical and practical studies made upon the subject by the author, and his high standing in the engineering world in France, some abstract of his opinions will be of value.

The Marquis de Chasseloup Laubat speaks with entire impartiality upon the question of the Belleville boiler, he having been considered in France as being rather prejudiced against it at the time of the bursting of tubes on the Jaureguiberry in the Lagrafel and d'Allest boiler, and he then demanded that exhaustive experiments be carried out with the principal types under trial, instead of adopting the Belleville boiler exclusively.

Taking up the points of the interim report seriatim, the Marquis comments upon them carefully and judiciously, and although we cannot in all cases agree with his conclusions they are certainly entitled to much weight.

Admitting the superiority of water-tube over tank boilers for military purposes, it is hardly correct to maintain that at the time when the Admiralty decided to adopt water-tube boilers that there was none but the Belleville which had been tried to such an extent as to warrant its use.

The statement that the circulation of water in the Belleville boiler is "defective and uncertain" demands explanation. It is evident that no water-tube boiler can give results either satisfactory or acceptable, if it has not a sufficient circulation for a normal rate of combustion. The whole question therefore depends upon the rate of

combustion. It is well-known that the Belleville boiler, or any boiler with "restricted" circulation will not stand forcing, and the fact that vessels fitted with Belleville boilers have run over thousands of miles without accident, while showing that the boilers did succeed in steaming at the rate of combustion at which those navigations were carried out, (a rather obvious conclusion) simply indicates how deliberately those navigations were conducted.

It is said that boilers such as the Yarrow, Thorneycroft, Du Temple, and others permit a more intense circulation than takes place in the Belleville boiler, and the Marquis replies that the Belleville was never intended to stand such intense rates of combustion as these express boilers, which is doubtless true. At the same time it must be remembered that the great object of introducing water-tube boilers into the naval service was to secure a form of steam generator which should permit immediate forcing to meet the sudden demands for steam so probable in naval evolutions. In such a battle as that at Santiago, in the Spanish-American war, the importance was seen of a steam generator which could stand an instantaneous demand for steam like the spurt of a race horse in the supreme moment of a contest, and a boiler with restricted circulation and consequent restricted firing and steaming capacity is utterly unequal to such demands.

Intense firing is altogether undesirable for cruising on long voyages or other deliberate evolutions, but if any piece of machinery is to be capable of overloading it should be capable through and through. A boiler with grate surface permitting a high rate of combustion, provided with a furnace adapted for forced draft, designed to withstand high pressures and emergency working, is after all no better than the old tank boiler for military purposes if all these advantages are destroyed because of defective circulation. All parts should be alike capable of meeting the call from the bridge for speed, and the open admission that the Belleville boiler "was never designed to meet such intense rates of combustion" is a plain statement of its unfitness for naval purposes.

In regard to the desirability of using automatic feed appliances, the Marquis is altogether right, and his opinion on that point is so clearly expressed as to render it desirable that it should be here repeated.

"In all modern machinery the tendency to-day is to secure safety by means of automatic apparatus, and not by a permanent attention of the staff in charge. More and more every day it is demonstrated that the human machine is the least trustworthy of all, especially in sudden cases of emergency; and, as men cannot be entirely dispensed with, it is being tried to reduce their duty to keeping up automatic arrangements. The continually increasing success of the United States competition against the Old World is mostly due to the fact that Americans—although they possess very intelligent and energetic workmen and engineers—carry as far as they can the principle and the applications of automaticity."

In closing, the Marquis thus sums up the interim report from his point of view, the point of view of probably the most capable and disinterested French engineer who could be named in connection with this most important subject.

"Water-tube boilers are to be preferred to Scotch boilers. Belleville boilers must be entirely thrown away.

"Nobody knows which type should be adopted in their place.

"Is it reasonable, fair, and scientific, to propose the radical abolition of an apparatus which, even in an imperfect manner, is the application of a necessary and indispensable principle without even knowing by what it may be replaced?

"I do not hesitate in answering, No. In my opinion the truth is just at the opposite of the conclusions of the interim report. Care must be taken not ultimately to condemn the Belleville boiler, before knowing whether there is a type of boiler which can give better results in actual service; it is absolutely necessary to carry on long practical experiments with the various boilers, the first trials of which have proved satisfactory.

"To sum up, I contend that even a defective solution of a problem must not be rejected, until it has been ascertained that a less defective one is at hand. I purposely say 'less defective', and not a 'better', because a marine boiler, as well as a warship, can only be a compromise.

Motor Vehicles for Heavy Traffic.

THE progress of motor vehicles for heavy traffic in the past five years is well shown by the address recently delivered before the Liverpool Chamber of Commerce by Mr. E. Shrapnell Smith, secretary of the Liverpool Self-Propelled Traffic Association.

Besides giving out the details of the trials for the present year, a review was made of the results of previous trials showing how the defects revealed by those trials were subsequently overcome.

"It is generally well known how the wheels of the vehicles which competed in the 1898 trials proved structurally defective when subjected to the hammering action of granite sets and cobblestones, whilst other minor troubles, *e. g.*, with the condensers and in respect of adhesion, justified that 'sitting on the fence' which was the policy adopted by our Liverpool teamowners and shipowners, and by Lancashire manufacturers as a whole. The second trials, which took place in 1899 immediately prior to and in conjunction with the Liverpool show of the Royal Lancashire Agricultural Society, provided satisfactory evidence that the tyre and adhesion difficulties had been overcome, for none of the wheels gave the smallest trouble and five out of the six competing vehicles successfully climbed, both unladen and laden, Everton Brow, Brow Side and Rupert Lane, where the inclination varies between 1 in 9 and 1 in 13, the heaviest load taken up and brought down again being six and a half tons. Yet, these trials did not satisfy the judges that the time was ripe for any extension or general adoption of motor wagons, for in their conclusions of December, 1899, they say: 'The difficulties imposed by meeting the limit of three tons tare under the locomotives and highways act, 1896, were again serious drawbacks to ideal construction. The strength of frames and working parts, the area of bearing surfaces, the width of wheel tyres, the available platform area, the stoutness of the platforms and woodwork generally, and the diameters of axles and shafts, were consequently reduced below what is compatible with a satisfactory life.'"

"In order to see whether manufacturers could improve their designs so as to produce an efficient vehicle under the three-ton limit of tare, the association decided to allow an interval of two years between their second and third trials. The result has been that all the vehicles have grown heavier, and there is now another strong argument in favor of the desired increase. As a tentative clause in the act, that controlling the tare has served its end of forcing manufacturers to put forth their best efforts in design and workmanship, but it is hard to imagine why the tare weight should not have been equal in the first instance to at least that unit of traffic which the motor vehicle replaces, viz., a lorry and three horses weighing, say, four and a half tons. Of course there was no experience of this type of vehicle in 1896, seeing that only light pleasure carriages of foreign build and traction engines existed. There is, however, every reason to hope that the engineer inspector, who will represent the president of the Local Government Board at the forthcoming trials, will be clearly satisfied that the extra weight involves no risk and possesses many advantages. In fact, it is important that disabilities should be removed before the end of the present session, and it cannot be gainsaid that an increase is all-important for the future development of road haulage. This means improved internal communication, the improving of land in agricultural districts and the provision of a light railway to the very door of every farmer in the country. There is no doubt that Liverpool stands to benefit as much as, if not more than, any other city or port in the country, but it is equally certain that the advantages of mechanical transport will gradually be appreciated throughout the United Kingdom. The average daily mileage of a motor wagon, when upon straightforward work, is from thirty-five to forty miles, and, whilst this distance, measured from many of our ports, brings one into sparsely populated districts, such range of action opens up great possibilities for Liverpool and a few other ports in particular. There is at hand in the self-propelled lorry an inoffensive means of conveying raw materials or merchandise from point to point without the intervention of any handling or breaking of bulk, in addition to which cartages are absorbed into the one journey and terminal delays are avoided. No elaborate preliminaries are required; neither Parliamentary powers nor permanent way."

REVIEW OF THE CONTINENTAL PRESS

The Computation of Masonry Arches.

ALTHOUGH the arch has been the subject of study and discussion from early times, it is only in the past fifty years that its technical literature has assumed definite form, and in spite of the many works which have been written, the practical work of construction has generally been conducted according to empirical methods.

An exhaustive review of the computation of the form and equilibrium of masonry arches forms an important contribution in a recent issue of the *Annales des Ponts et Chausées*, by M. Legay, and some examination of his treatment is here given.

Nearly all writers upon the subject make the error of assuming the form of arch as given, and then proceed, by methods more or less intricate, to find the conditions of equilibrium resulting from various conditions of loading. M. Legay gives the credit for the first true conception of the nature of the problem to M. Denfert-Rochereau, who, in 1859, announced that the load alone should be assumed as given, and that from this, for any span and rise, should be computed the form and dimensions which should satisfy the following conditions:

1. That the resultant of the pressures should pass through the middle of each joint, thus giving a uniform pressure over the entire surface.

2. That the resultant of the pressures should act normal to each joint, thus requiring no resistance, such as friction, to be provided to oppose sliding.

3. That the pressure per unit of area should be the same upon all the joints, this requiring an area in each case proportional to the pressure upon each joint.

4. That the pressure per unit of surface should correspond to the greatest resistance which the material is capable of sustaining without alteration of its elasticity.

M. Denfert-Rochereau proceeded to solve the problem for a linear arch and having thus determined the form he drew the joints normal to the curve, giving a depth of voussoirs dependent upon the resistance of the material employed, but his analysis was very complicated besides giving only approximate results. The principal defect in his method was the assumption that the curve of equilibrium determined for a linear arch would be maintained for one of a determinate thickness, this really being true only when there are hinges at the crown and springings to compel the passage of the equilibrium curve through determinate points.

Taking up the points proposed by M. Denfert-Rochereau, and modifying them to correspond to the difference between the linear arch and the various possible arches of finite thickness of voussoirs met in practice, M. Legay proceeds to devolop the various equations necessary to enable the true equilibrium curve for a given loading to be determined. This curve, while corresponding in form and equation to the catenary, differs from it according to the loading, the position of the parameter depending upon the load. The result is what Rankine called the "transformed catenary," but which M. Legay has termed a "catenoid." By insisting on determining this curve in advance of the selection of the form of the arch, a most important point has been made, and this cannot be too strongly emphasised. The common, and wholly wrong-headed practice of selecting a form of arch and then endeavouring to determine the location of the line of pressure and the points of rupture, he proposes to replace by the rational method of determining the position and shape of the line of pressure about which any desired form of arch may be constructed.

The formulas deduced in the paper enable the curve to be constructed readily, especially with the aid of a table of hyperbolic functions. For ordinary masonry arches, constructed without hinges, the best plan is to consider them as built-in at the springings, this being generally in accordance with

the facts, and thus reducing the arch proper to the middle portion and making it correspondingly flatter; and M. Legay gives, among other tables, those especially adapted to these conditions.

The principal defect in any analytical treatment of this problem lies in the limited number of conditions to which formulas and tables can be applied. The transformed catenary, to use Rankine's term, is only discussed analytically for a stationary load carried up to a given horizontal height above the key, while in actual practice various distributions of fixed load must be considered, and the moving load, especially in the case of railway bridges, must be examined.

Accepting all of M. Legay's premises, and affirming especially the position that the curves of pressure should be determined and the arch constructed about them, instead of assuming the shape beforehand, it should be considered that the graphical method affords a wider scope and greater certainty in results than any analytical method possibly can do. By constructing a force polygon for the stationary loading, which can easily be done, however irregular it may be in magnitude and distribution, and then adding to this the variations in shape due to the successive positions of the moving load, a core or kernel, within which all the equilibrium curves lie, is found, and about this kernel the actual arch may be drawn in such a manner as to bring the pressures practically normal to the joints and very near the middle of the voussoirs, thus fulfilling all the conditions of M. Denfert-Rochereau, and avoiding the elaborate analysis of M. Legay, while at the same time greatly extending the scope of the problem.

The Performance of Shearing Tools.

In the April issue of THE ENGINEERING MAGAZINE there was reviewed in these columns the first portion of a study by M. Codron relating to the power required for various operations of machine tools, that portion relating to the performance of grinding tools.

This is now followed by two successive installations, published in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, examining in a very exhaustive manner the action of shearing tools.

The operation of shearing involves a certain degree of malleability in the material worked, wrought iron, for example, being suitable, and cast iron unsuitable, for this operation.

In the case of ordinary shearing, such as the cutting off of a bar of iron at the forge, using hand tools, the cutting tool acts as a wedge, the vertical force being opposed, not only by an opposite vertical force, but also by two lateral forces, acting in directions normal to the faces of the wedge-shaped cutting tool. These latter forces act to produce a longitudinal stress on the material, uniting with the cutting action of the edge to produce the desired separation. Besides these two actions there is a third, the friction of the surfaces of the tool upon the newly cut surfaces of the metal, this being a resistance which, while opposing the effort of the tool, does not correspond to any cutting effect.

In analysing mathematically the relations of these opposing forces, M. Codron calls attention to the fact that of the three resistances to the tool, only that which opposes the longitudinal tension upon the material is capable of calculation, the direct cutting action of the edge, and the friction of the surfaces of the tool upon the metal being indeterminate.

The angle of the wedge which constitutes the tool is an important element in determining the resistance, and this angle may vary from 20°, for a soft metal, such as lead, to as high as 70°, for iron, the more obtuse angles being necessary in order to prevent the breaking of the tool.

The resistances to shearing are naturally different at different stages of the operation, the first effect being limited almost entirely to the penetration of the cutting edge below the surface of the metal. Further progress causes the other resistances to assume a proportionally greater influence until a maximum is attained before the piece is entirely sundered, this point varying with different materials and tools, the concluding portion of the operation showing a continually diminishing resistance until the operation is completed.

In order to examine the action of shearing tools in detail, M. Codron has studied the manner in which such a soft metal, such as lead, behaves, and by employing accurate testing machines, and plotting the forces un-

der various conditions as curves, he has deduced the general manner in which shearing of metals is effected. Similar investigations with copper, with iron, and with steel, the general co-efficients for the resistances of cutting and of friction being thus experimentally determined, for various angles of tools.

By plotting the results, using ordinates to represent pressures upon the tools, and abscissas to show the penetrations, the relations of the forces are very clearly shown, and by scoring the surface of the test piece with vertical and horizontal lines it is possible to observe the extent of the deformation of the material in the vicinity of the sheared section.

For the details of the various tests reference must be had to the original papers, but the general results may be indicated and some conclusions drawn.

The curves plotted as above indicated, giving the relation of pressure and penetration are very nearly parabolas, and as the areas included measure the work performed, the work may be taken as equal to two-thirds of the product of the maximum pressure and the total penetration. For thicknesses below 15 millimetres the maximum pressures are very nearly proportional to the cross section of the test specimens, while for greater thicknesses the required pressures are greater.

For a very ductile material, such as lead, the cutting action is maintained nearly through the entire thickness of the severed piece, and hence the curve obtained by plotting the results is complete. For copper, however, the cut does not extend through the entire thickness, a sudden rupture taking place towards the close of the operation, the metal being torn apart as the tension, due to the wedging action of the tool becomes too great for the diminished section. This is true in a still higher degree in the case of iron or steel, and in all these cases the curve can only be completed by analogy, prolonging the trace to the abscissa indicated by the total thickness.

M. Codron made numerous experiments with shearing tools of various angles of acuteness, these showing, as might be expected, that the efforts increased rapidly with the increase of the angle of the tool. From these experiments he deduced general expressions from which the most efficient angle may be obtained and also by which the work required for shearing a given piece may be computed.

The action of two opposing shearing tools forms an important part of M. Codron's investigations, leading, as it does, to the consideration of machines using double rotary cutters. The use of rolling cutting tools in connection with roller chains for the purpose of cutting off pipe is also considered.

Nearly all the experiments described were performed with cold metals, but some trials were made in cutting off hot iron, and although the results were from only a few trials, it appears that the resistance of red-hot iron to shearing is between one-third to one-fourth that of the same metal when cold.

These researches upon the behaviour of materials subjected to various workshop manipulations are to be continued, and when completed, will form a valuable addition to technical information.

The Press-Forming of Materials.

A NEW method of working materials by pressure, known as the Huber system, has recently been brought out in Germany, and from a very enthusiastic account given by Professor Riedler in recent issues of the *Zeitschrift des Vereines deutscher Ingenieure,* the following abstract is given.

The earlier methods of producing designs in relief were by the use of the hand hammer, the drop hammer, or the forging or sheet metal press, dies being used, and the force of the blow or pressure taken up upon an anvil or by the framing of the machine. The objections to these methods are many. The necessity of providing the proper abutment to oppose the pressure, and the consequent danger of springing the framing of the apparatus are evident. The wear and tear upon the dies is well known, breakages being not uncommon, while the high cost of the dies, when made sufficiently substantial to resist the operations, is an important element.

The Huber process is simplicity itself, as it consists in placing both the material and the die in the interior of the cylinder of the press, so to speak, or in other words, in the inside of a vessel containing the water, the whole being thus subjected to pressure on all sides. By simply making the die of a

material of somewhat greater resistance than the metal to be stamped, the latter is forced into every line and modulation of the die surface, thus producing a perfect reverse copy. Since sheet iron or sheet steel reaches the flowing point at or near a pressure of 60,000 pounds per square inch, it follows that a hydraulic pressure of about 75,000 pounds per square inch should be sufficient to obtain any effect which may be desired. Since the liquid pressure acts upon the inside as well as the outside of the object to be stamped, the method enables designs to be impressed upon the exterior of delicate hollow articles without changing the shape in the least, the dies being placed in contact with the outside surface, and a luting of cement placed around the edge to prevent the pressure from getting between the surfaces. The die need not be unusually heavy, since the pressure acts upon the back at all points, and the absolute uniformity of the liquid pressure in all directions entirely precludes any deformation of the object or of the die, the latter being simply stuck upon the surface of the article to be embossed and both immersed in the water and the pressure applied.

The packing around the edge of the die is required merely to prevent the film of liquid pressure from getting between the surfaces before the hydraulic pressure can force the metal to flow into the lines of the die, and various materials have been successfuly employed for this purpose, a sort of rubber cement having been found very suitable. Any lack of density in the packing is remedied by the effect of the pressure, and the same packing may be used indefinitely and repeatedly.

Professor Riedler shows many excellent examples of work produced by this process, the pressure in most cases being about 75,000 pounds per square inch, although pressures as high as 100,000 pounds have been successfully employed for some materials, this last being as high as has been found necessary in any case.

An important feature in connection with the process is the comparative cheapness of the dies. In the case of the older forms of presses the dies are most expensive, requiring many weeks' time of skilled die sinkers for their cutting, after which the steel must be hardened, during which latter operation many dies are injured or lost through by warping or cracking. In the new process hardened dies are not necessary, even bronze being sufficiently hard, and such dies can be made by using electrotype copies of models in some plastic material, thus permitting a wide range of designs to be used without prohibitive cost.

In some instances it is desirable to employ the process upon hot metal, in which case sand may be used instead of water for the medium for transmitting the pressure. It has been found that the addition of a zinc-iron alloy to the sand adds to its fluidity, giving it a talc-like consistency, and acting somewhat as a lubricant.

Professor Riedler naturally gives much attention to the hydraulic machinery used in connection with the process, and shows several varieties of hydraulic presses for use for various kinds of work. In view of his eminence in all that relates to the design of hydraulic machinery, his high opinion of the process and its possibilities must attract attention to it, and there is every probability that this rational method of working metals by pressure will be applied in many branches of industry.

Progress in the Utilisation of Furnace Gases.

About three years ago the well-known German metallurgist, Herr Fritz Lürmann, in a discussion before the Verein deutscher Eisenhüttenleute, took the position that blast-furnace gases could hardly be used to advantage in internal-combustion engines, chiefly because of the large proportion of dust which would prove injurious to the cylinders of the engines. At the recent meeting of the same society, held at Düsseldorf, reported in *Stahl und Eisen*, Herr Lürmann takes up the same subject and shows how the difficulties have been overcome together with the progress which has been made.

The objections which were originally made to the use of furnace gases were: (1) its variable composition; (2) the small proportion of combustible gases; (3) the presence of dust and of metallic vapors; (4) the presence of vapor of water.

Taking up these objections in order, in the light of the experience which has been had since 1898, it appears that they were partly unwarranted, and have otherwise

been practically overcome. The varying composition of the gases seem to have produced little or no effect upon the action of the engines, especially when the discharge of several furnaces has been delivered into one main, and mingled before using.

The small proportion of combustible constituents in the gas, or as it is commonly termed, its leanness, has also been found no objection. The only result of the character of the gas is the necessity for a slight increase in the diameter of the cylinder of the engine. Thus one cubic metre of furnace gas, with a thermal value of 880 calories requires for its combustion 0.71 cubic metres of air, or in practice about one cubic metre is allowed; thus giving 2 cubic metres of explosive mixture, furnishing 880 calories. A cubic metre of illuminating gas, with a thermal value of about 5,225 calories, would require for its complete combustion in the cylinder of an engine, 7 cubic metres of air, giving a total of 8 cubic metres, of which 2 cubic metres would then have a value of 1,306 calories, so that for equal power the cylinder for an engine using furnace gas would have to be about 50 per cent. larger volume than if illuminating gas were used. Furnace gases often show a calorific value of 900 to 1,000 calories, and at the Mansfield Copper Works at Eisleben a Körting gas engine is operating satisfactorily with a gas containing only 700 calories per cubic metre. For use with lean gas it is desirable to have a somewhat higher degree of compression than for the richer gas, but this requires only a slight modification in the construction of the engine.

The influence of dust in the gas requires especial consideration. With regard to the nature of the dust a careful distinction must be made between the finely divided coke, iron-ore, and limestone, and the metallic portion. The metallic content may be partly in the form of particles and partly as metallic vapor, the latter being oxidised in the cylinder and there precipitated in the form of dust. Heavy particles of dust may be separated by gravity from the gas before delivery to the engine, but the very fine dust may be carried for hundreds of feet, floating in the gas, but mixing with the lubricant in the cylinder, there forming a gritty substance capable of injurious action upon the rubbing surfaces. Herr Lürmann contended, more than three years ago, that furnace gases should be passed through a wet scrubber before delivery to the cylinder, and this position is generally confirmed in practice. In fact, in his recent communication at the meeting of the Iron and Steel Institute, M. Greiner, of Seraing, admitted the desirability of scrubbing the gas. At Seraing, the gas is used successfuly just as it comes from the furnaces, but in Luxembourg, where the gas is much dirtier, wet scrubbers are satisfactorily employed.

The presence of the vapor of water in the gas appears to offer no inconvenience in practice, as the many engines in continuous service show.

In order to give an idea of the extent to which furnace gas has been introduced as a fuel for gas engines, a table is given of the product of the various firms building engines for this purpose, the record being brought down to April, 1901. The total at that date was 77,545 h. p., of which 18,000 h. p. came from the Cockerill works at Seraing, Belgium; 13,350 h. p. from the Otto works at Deutz, and 16,300 h. p. from the Deutsche Kraftgas-Gesellschaft, the builders of the Oechelhaüser engine.

It is interesting to note that in America, the country producing the greatest output of iron and steel, no engines driven by furnace gases are in practical use. In England, where the idea first originated, but few are in operation, while in France about 8,000 h. p. of small gas engines is in use. The little principality of Luxembourg, with a population of only 236,600, has large engines to the extent of nearly 10,000 h. p. installed, while in Belgium there is 7,600 h. p., and in Germany nearly 45,000 h. p.

Herr Lürmann gives descriptions of various devices in use for scrubbing and purifying the gas, including centrifugal purifiers for removing the heavier particles of dust, and washers for precipitating the finer dust. Plans of the gas-electric installation at the Gutehoffnungshütte at Oberhausen, and the gas-blowing engine plant at Differdingen are also given, and many details of the operation of these and many other large plants.

The great question, in view of the actual success of the installations in use, is one of

cost. The large volume of gas delivered by blast furnaces, about 4,500 cubic metres per ton of iron, and the first cost of a plant capable of scrubbing such quantities of gas are are produced by modern large furnaces, must be considered. From data obtained from a number of large plants, it appears that the cost of installing a purifying plant ranges from 4 to 6 marks per cubic metre of gas purified per hour, and in the instances in practice this has been found satisfactory.

Herr Lürmann's paper contains much valuable information as to the present status and practice of this important industrial subject, and should go far toward furthering the extension of this method of utilising a valuable waste product.

Boilers and Engines for Superheated Steam.

WITH the fuller understanding of the wasteful effects of cylinder condensation in steam engines, and with the improvements in the manufacture of high-temperature cylinder oils, there has come a revival in the employment of superheated steam. It is generally admitted that superheating is at present the most effective way to diminish internal losses due to condensation in the cylinder, and in practice the results have been such as to confirm the theoretical deductions.

In a paper recently presented before the *Verein deutscher Ingenieure* at Essen, by Herr Hunger, the recent advances in the production and use of superheated steam are discussed, and some interesting practical points brought out.

The proper use of superheated steam involves consideration both of the boiler and the engine, the superheater properly being an extension of the steam generating end of the plant, while the engine should be especially designed, if the best results are to be attained. The importance of designing the whole plant with a view to the use of superheated steam has been especially emphasised by Herr Wilhelm Schmidt, who has realised some remarkable results with the engines and boilers constructed according to his plans.

In regard to the boiler, it is of much importance that ample space be provided in the flues to receive the superheater, and that an increase in chimney draft be given to offset the increased resistance to the gases in passing through the space about the superheater tubes. When proper care is not taken it is found that the boiler efficiency is reduced by the introduction of a superheater, but Herr Hunger cites a case of a boiler which was thrown out because of its poor efficiency, and which when properly reset, in connection with a superheater showed the high efficiency of 78 per cent.

The steam engine should be designed with especial reference to the use of superheated steam. It is a common error to make the cylinder too small, using the same dimensions as would be required for saturated steam. In a given engine, for the same point of cut-off, steam superheated to 300° to 350° C. gives less power than saturated steam. The pressure of superheated steam falls more rapidly during expansion than is the case with saturated steam. For these reasons it is necessary for the same power, to make the diameter of the cylinder somewhat greater for use with highly superheated steam than when saturated steam is employed. With many forms of engine it is impossible to use steam heated above 300° C., because of the effects of expansion upon the metal of the cylinder. When the ports are cast upon one side of the cylinder, the unequal expansion causes a warping and curvature which may cause the piston to bind, producing excessive friction and wear. In the case of a 1,500 h. p. engine tested by Professor Schröter, it was found impossible to start when the temperature was raised above 220° C., as the piston bound in the cylinder. For the same reason it is difficult to obtain good results with slide valves, or with cylindrical valves, and poppet valves have been found preferable. Many such points have arisen in the attempts to use highly superheated steam in practice, and hence it is important that such difficulties should be known and considered in new installations.

Herr Hunger calls attention to several points of importance in connection with the design of superheater plants, which embody the results of much experience. The best boiler for this service is the shell boiler with large steam and water space, permitting good combustion, and generous proportion of flues. The earlier superheaters consisted of arrangements of spiral tubes, connected

in such a manner that the whole was disabled in case of a leak, involving the tearing out of a portion of the boiler brickwork in case of repairs. Modern practice avoids the use of right-and-left threads or other joints exposed to the action of the heat, and provides for access to all the points from the outside, without disturbing brickwork; and it should be possible to cut out any section in which a leaky tube or member may occur without disabling the entire system. With regard to the engine, the general form of the modern steam engine may be followed, but especial care should be taken that the high temperatures shall not act to curve the cylinder. The valves and stuffing boxes must be constructed to withstand the heat, and to remain both tight and free to move.

Superheaters are generally placed behind the boilers, in the flue leading to the chimney, although when the space is too contracted to permit of this arrangement, a chamber may be constructed above the boiler. Care should be taken to permit the superheater tubes to be well drained, as otherwise water is apt to collect in the lower portion, and in spite of the heat it remains difficult to dislodge, since in most instances there is no provision for water circulation. The space taken up by the water diminishes the capacity of the superheater, and the water is apt to be carried over suddenly to the engines, with disastrous results.

In designing the flues for conducting the gases to the superheater, arrangement should be made to divert a portion of the gases from the superheater by a by-pass, otherwise, when the boiler is forced, excessive superheating may result, to the injury of the engines. A rate of combustion of about 80 kilogrammes of coal per square metre of grate (about 16.5 pounds per square foot) has been found to deliver the gases to the superheater at a sufficiently high temperature to insure satisfactory superheating; the proportion varying somewhat with the character of the boiler and the nature of the fuel.

In some cases, where the boiler plant is already in use, and superheating is desired, it has been found preferable to construct a separately fired superheater. The principal objection to this apparatus lies in the fact that the gases coming directly from the fire are too hot to be permitted to come into immediate contact with the superheater, as too high a degree of superheat would be produced and the tubes would also speedily be destroyed. Such furnaces have been arranged to admit a proportion of external air to mix with the hot gases, but this is a wasteful method, and it is better to arrange a feed water heater to receive the first force of the fire, and permit the gases then to reach the superheater.

Data from a number of tests are given, showing the economy of engines working with superheated steam, the best of these being a 200 h. p. engine, tandem-compound, which with steam superheated to 346° C. required 4.87 kilogrammes steam (10.07 pounds) per indicated horse-power-hour.

Radiations from Metals.

EVER since the discovery, in 1896, by Becquerel, of the property possessed by the metal uranium of emitting rays similar to those produced by the Crookes tube, the subject has been carefully studied, especially by Mme. and M. Curie and by M. Debierne, the results having been given to the world in successive communications to the French Academy.

In a recent issue of the *Memoirs of the Société des Ingénieurs Civils de France* an excellent review of the whole subject is given in a paper by M. Paul Besson, and the possibilities of the subject render some abstracts of his communication appropriate.

The action of these rays is most curious, since they produce electricity, excite chemical action at a distance, act upon photographic plates through opaque bodies, and, under certain conditions, are spontaneously luminous.

Such unexpected phenomena are worthy of the study of all who are interested in that applied science which constitutes the engineering of to-day, since they indicate altogether different ideas concerning the nature of things from those which we are accustomed to have. Becquerel discovered these rays to be emitted by the metal uranium, but in experimenting with pitch blende (oxide of uranium) and with chalcolyte a new element, having chemical properties similar to bismuth, was discovered, this being called "polonium." This was followed by the isolation of another element belonging to the same group as bari-

um, and called "radium"; while, in 1899 Mr. Debierne discovered a third element, resembling thorium, and named by him "radium." Among various properties, these newly discovered metals possess what has been called "radio-activity" in a high degree. This action must not be confounded with phosphorescence or fluorescence, since it does not appear to have been obtained from any external source, such as absorption of calorific, luminiferous, ultraviolet, Röntgen, or, cathode rays. On the contrary there appears to be an undiminished emission of energy, even after all possible precautions have been taken to isolate the metal from all external radiations.

The properties of these rays have as yet been only partially investigated, they include photographic action, deviation of the magnetic field, modification of the electrical conductivity of air, discharging action upon electrified bodies, but they are not capable of reflection, refraction or polarisation. M. Besson examines at length the results of the various investigations of Mme. and M. Curie, and to his paper reference must be made for a more detailed account.

To the engineer the principal features of interest which these phenomena present are those which bear upon his pre-conceived notions of the ultimate constitution of matter. We find ourselves possessed of certain bodies which are spontaneously luminous, producing electricity, acting upon photographic plates, coloring glass, and at the same time sustaining no appreciable change. These substances produce energy without apparently receiving it from any external source. They appear to contain within themselves an indefinite supply of power. These are facts which overturn all our ideas of mechanics, physics, and chemistry.

In whatever way we endeavor to explain the phenomena we find ourselves in a new field, calling upon us to modify our previous views of matter and energy. Matter, heretofore considered as in itself inert, is seen to be filled with activity sending emanations of all kinds forth into space some luminous, others atomic, combining, reacting, modifying living matter, producing sensations, and for all we know, inspirations. Psychical phenomena may be found to consist of effects wholly dynamical, but as ever before, due to an unknown cause, a cause which recedes constantly as we approach, and which seems more and more remote as we discover effects, which, while new to us, have been existing continuously in the past as we find them in the present.

Underground Transport in London and Paris.

In view of the strikingly similar conditions existing between the completed portion of the Paris Metropolitan and the London "twopenny-tube" it is of interest to compare the results of their operation. Each line follows the diameter of a great capital, the lengths being practically the same, 6½ miles, the traction systems similar, and the date of opening differing by less than two weeks, the Paris road being open on July 19 and the London one on July 30, 1900, and both being in full effective operation on August 12, of the same year.

According to the published reports, the London road at first surpassed in daily passenger traffic, the figures being about 80,000 for London, and 45,000 for Paris. As might be expected in time of an exposition, however, Paris soon passed London, and by October the figures stood at 85,000 for London and 105,000 for Paris. The London traffic, however, continued to grow, and during December it reached a daily total of about 100,000. In Paris the traffic did not fall off at the close of the exposition, but continued to grow, passing 130,000 per day, at the close of December.

The mean daily totals of passengers from the beginning of August to the close of December, 1900, were for London, 92,910, and for Paris, 103,930, while taking the months since the close of the exposition, the corresponding averages were 97,440 for London, and 115,232 for Paris. In round numbers it is estimated that there will be 40,000,000 passengers per year in Paris, and 33,000,000 in London.

In spite of the difference in passenger totals, the receipts of the London road have been greater than in Paris. In London, the daily receipts have averaged £804, or about 20,270 francs, while the daily receipts of the Paris Metropolitan have averaged, since the exposition, 19,614 francs. This difference may be due to the fact that the price in London is twopence (0.21 franc) for all distances, while in Paris it varies from 0.10 to 0.25 franc, according to the class.

REVIEW OF THE AMERICAN PRESS

The Testing of Steam Engines.

THE committee appointed by the American Society of Mechanical Engineers to codify and standardize the methods of making steam engine tests has made a preliminary report, which, while presented for the purpose of eliciting discussion and amendment, yet doubtless contains the general principles which will remain as the foundation of the final report.

Starting with definitions, it is plainly declared that the object of an engine test is broadly the determination of the economy with which the engine produces a given amount of power; this involving two elementary quantities, the amount of steam, fuel, or heat consumed, and the amount of power developed.

As it is the engine alone which is the subject of test, it is important to eliminate boilers, furnaces, or fuels, as elements, since these include variations which would render the results non-comparable. The only unvarying unit expressive of energy consumed is the heat unit, and it is therefore a foregone conclusion that the standard of consumption for all heat engines should be referred to heat units. The measure of power delivered is left as the old term horse-power, this being so generally understood as to need only the division into indicated and brake horse-power, to be altogether satisfactory.

The committee says:

"The expressions of engine efficiency which meet both the requirements noted, are the number of heat units consumed per hour, both per indicated horse-power and per brake horse-power, and these we recommend as the desired standards of comparison. The heat unit standard does not interfere in any sense with the common terms of expressing efficiency of engines. The hourly weights of coal, gas, or other fuel, or weight of steam, consumed per horse-power, heretofore commonly employed, are additional forms of stating the efficiency, and are none the less useful within their limitations. They should by no means be abandoned. Neither should the standard forms recommended for expressing the duty of pumping engines, or the efficiency of locomotives, previously accepted by the society, be changed. There is no conflict here with the proposed new standard. In the scheme presented by your committee these various additional or subsidiary forms of stating efficiency, as applied to particular classes of engines or kinds of service, are suitably provided for.

"The heat consumption of a steam engine for the standard test is ascertained by measuring the quantity of steam consumed, calculating the total heat of evaporation of the entire quantity, and crediting this total with that portion of the heat rejected by the engine, which is utilized and returned to the boiler. The term 'engine' as here used should include the entire equipment which is concerned in the production of the power, embracing the main cylinder or cylinders the jackets and reheaters, the air, circulating, and boiler feed pumps, if steam-driven, and any other steam-driven mechanism necessary to the working of the engine. We believe that the heat unit standard makes it both desirable and obligatory to thus charge the engine with the steam used by necessary auxiliaries, for the reason that it is itself finally benefited by the heat which they return, it being generally agreed that exhaust steam from such auxiliaries should be passed through a feed water heater, and the heat thereby carried back to the boiler.

"The heat consumption of gas, oil, or other engines of the internal combustion class, is found by ascertaining the total heat of combustion of the particular fuel used, which should be determined by a calorimeter test, and multiplying the result by the quantity of fuel consumed.

"The indicated horse-power for the proposed standard is that determined by the use of steam engine indicators. It should

be confined to the power developed in the main cylinder or cylinders, and should not include that developed in the cylinders of auxiliaries."

The main difference between the preliminary report and that of the "Thermal Efficiency" committee of the Institution of Civil Engineers appears to be in the inclusion of steam-driven auxiliaries in the American code as chargeable to the engine, but since the test is primarily a commercial matter it appears reasonable that the consumption of the auxiliaries should be included, although it is most desirable that they should be in such form as to be capable of independent investigation.

The code appears to be most complete in all its provisions, but its examination had best be deferred until it shall have passed the ordeal of criticism for which it was put forth, and with this end in view all who are interested in engine tests should procure and examine it.

Transportation Across the Hudson at New York.

For a long time the question of a bridge across the Hudson river at New York, to enable the important railways converging on the opposite shore of New Jersey to enter the metropolis, has been discussed, and hence the paper of Mr. C. W. Buchholz, recently presented before the New York Railroad Club, treating of the general problem of all-rail transportation across the Hudson river at New York City, is to be welcomed, treating as it does of the general considerations which enter into the subject.

In order to form a clear opinion upon the practicability of bringing the railway communication across the river, or indeed, as to the desirability of doing so at all, it is necessary to consider the present conditions of transport to and within New York. Briefly the problem is that of bringing into New York, in train loads, all the immense traffic which is poured daily into Jersey City and its adjacent towns by three trunk lines and by three railways of nearly equal importance. This freight, exclusive of coal and grain amounts to about 30,000 tons, or 2,000 car loads per day.

"The impossibility of accomplishing this proposition will be apparent to everybody when it is considered that these railway companies occupy now, with their docks, piers, stations and warehouses, more than four miles of the Hudson River front on the Jersey side opposite the city of New York, and that every one of these six railway companies has covered many hundred acres of land with its tracks for miles back from the harbor for the purpose of having adequate terminal facilities to transact the constantly increasing business with New York. To transfer all this business to one or more freight stations in this city, or only so much of it as must find its way rapidly for immediate consumption or storage to warehouses and stores without counting what goes directly for re-shipment to vessels, and to do such business with dispatch, would require an area equal to that enclosed between the two rivers and between 14th and 23d Sts., and would necessitate a network of track from one end of the city to the other, either above or below the streets."

Apart from the physical difficulties connected with the problem there must be considered the desirability of accomplishing it.

"Manhattan Island, with its great city, is phenomenally fortunate in its situation, although cut off by water from the rest of the continent. Its narrowness and its length, accessible everywhere to deep-draft vessels, to floats and to barges, enables the transportation companies cheaply and quickly to deliver freights and goods always at the nearest point to the warehouse or store of the merchant. Very little hauling by teams would be necessary if the city of New York would improve its river front and set apart for the use of railway companies, at certain fixed distances around its whole circumference, the necessary piers and docks to be operated by one general terminal company, whose duty it would be to receive and deliver freights to any of these points and at any of the railway depots in Jersey City."

At the present time every one who is at all familiar with New York realizes the difficulties which are daily encountered in the transport of such traffic as is absolutely compelled to traverse the length of the island. During the rush hours of the morning and afternoon the congestion upon the few possible longitudinal lines of transport, whether steam or electric, elevated or surface, is daily becoming greater, while with this is mingled the most obstructive of all

kinds of traffic, that of the horse-drawn truck. To add to all this the distribution of the great mass of merchandise which a bridge would concentrate at one point, would be to take from New York the use of one of its greatest advantages for distribution of merchandise, the river. To substitute for this great diverging outlet a converging one, bottling up the traffic, instead of distributing it along one of the finest water fronts in the world, hardly seems conceivable.

For passenger traffic, there is something to be said for the idea of a bridge, but even in such case the advantages are contingent upon certain modifications in the existing order of things. It is the coming traffic which must be considered, rather than the present, and this depends not only upon the increase in volume, but also upon possible changes in direction and distribution, changes which the nature and location of the bridge itself might do much to determine.

"In round numbers about 100,000,000 people cross and re-cross the Hudson River every year, of which amount about 40% arrive by trains at the various termini of the railroads. There are now five such passenger stations at Jersey City, Hoboken and Weehawken, belonging to the Central Railroad of New Jersey, the Pennsylvania R. R., the Erie R. R., the Delaware, Lackawanna & Western R. R. and the West Shore R. R., where all passengers destined to or coming from New York, suburban as well as distant, are delivered, together with those coming from branches and connecting lines that have no termini of their own. The total number of passenger trains daily arriving and departing from these stations is about 1,080; those trains reach and leave there on ten main tracks and are distributed at the stations upon 48 tracks provided with a corresponding number of platforms. These figures give an approximate idea of what will be necessary to transport this traffic across the river and what will be necessary to accommodate and handle it with dispatch at the terminus in New York."

It cannot be expected that the construction of a bridge as far up as 23rd St. would induce even a major portion of the present traffic to abandon the ferries. The downtown district must ever remain the financial and office business section of New York, just as the City maintains its similar position in London. At the same time it must be evident that a great portion of the general and retail business of New York is moving northward, both occupying locations readily accessible from such a bridge terminal, and at the same time diminishing the available residence area on Manhattan Island. The mass of people engaged in business in this great central area will be largely compelled to reside across the river and in the suburban tributary towns of northern New Jersey, and the construction of a bridge would have a profound influence both on the location of the newer business district of New York and the extension of suburban residence sections tributary to it. From this point of view the advantage would be as great, if not greater to New Jersey than to New York, and if a bridge is to be constructed and used it must be with the co-operation and aid of New Jersey.

"But without the assistance of the various cities and towns on the Jersey side of the river, and without the active co-operation of the city of New York by direct contribution, or by municipal grants, it will be almost impossible to execute and to operate successfully so stupendous an improvement, and especially so from a legal point of view. If New York city would cast aside its fear that a bridge across the Hudson river would drive half its population into New Jersey, or at least retard its own growth northward, for which purpose the city is now spending so much money; if New York would grow to the full height of its destiny and look upon the cities opposite the river in New Jersey as she does upon Brooklyn, as being a part of herself, perhaps we then might all live long enough to point with pride to a structure, magnificent in its lines and proportions, spanning one of the grandest rivers in the world and unsurpassed in history as a work of engineering skill and of civic enterprise."

The Study of Hydraulics.

THERE are probably few subjects about which so much has been written and so many theories advanced as the apparently simple matter of the flow of water in a given channel, and yet there are few about which so little positive knowledge has been

obtained. The accepted formulas are for the most part empirical, and can be safely applied only to channels closely resembling those from which the experimental data have been obtained, and unless those conditions are known serious errors are apt to occur.

In a paper presented to the Detroit Engineering Society by Mr. George H. Fenkell, and published in the *Journal of the Association of Engineering Societies,* there is given a general study of the various formulas, comparing their origin, character, and applicability, and this paper, together with the appended discussion by several well-known engineers, is a welcome contribution to the subject.

In beginning, Mr. Fenkell says: "The student in hydraulics at first is often led to believe that the formulas for the flow of water through channels of different kinds, through orifices and over weirs, are derived from certain well-known laws, such as those of gravity and friction, whose character and nature have been so thoroughly studied that they admit of little or no variation. His belief in that line is strengthened when he finds how long many of these formulas have been in general use and the number of years they have appeared in precisely the same form in text books and manuals.

"If the subject is pursued farther, however, it will be observed that all have been founded upon, or at least verified by experiments made at different times, by different persons and under various conditions. Many have evolved formulas from their own results and perhaps a limited number of others that agree with their own fairly well, disregarding those made under as favorable conditions, but which do not seem to follow the same laws.

"A large number of formulas have been derived to determine the friction in closed pipes or conduits running full, under pressure, such as cast iron, wrought iron, steel, and wood; and so often, in fact, has this ground been beaten over, that many, after various attempts to find rules that will fit all cases, have given up in despair."

In order to obtain some sort of comparison between such conflicting methods, Mr. Fenkell has undertaken the most laudable task of weighing and plotting a great number of observations and formulas, with the purpose of determining the value of the constant c in the Chezy formula: $v = c \sqrt{rs}$ and the paper is mainly composed of the collection and arranging of the data. These data are chosen altogether for pipes, and the relation between friction head and velocity head naturally enter largely into the question. The friction head being taken as equal to the velocity head multiplied by a constant, plus a constant, can be plotted as a straight line, and Mr. Fenkell thus determines it from a large number of experimental data.

The Chezy formula, it is shown, may be modified so as to permit different exponents for "r" and "s," and taking the exponent of "s" as equal to 0.5, it appears that a somewhat larger value for the exponent of "r" renders it possible to consider the coefficient "c" as practically constant.

In discussing Mr. Fenkell's paper, Mr. Allen Hazen calls especial attention to the extent to which the coefficient "c," assumed by Kutter and other noted investigators to be necessarily variable, may be made practically constant for any given material and surface by choosing the proper exponent for "r." Writing the Chezy formula as: $V = CR^x S^y$, originally suggested by Tutton, and making the exponent $y = 0.50$, it appears that "x" should be somewhere between 0.50 and 0.75, the latter value having been proposed by Sullivan in his "New Hydraulics." Mr. Hazen, from a graphical comparison of plotted data, drawn upon logarithmic paper, finds that if "x" is made equal to 0.625, C will remain practically constant for a given character of surface, thus greatly simplifying the determination of the discharge of pipes, and by using the slide rule for the computations the labor of calculation may be greatly diminished.

The discussion upon Mr. Fenkell's paper contains much interesting matter contributed by a number of experts in the study of hydraulics, and among the features included may be mentioned some data contributed by Mr. John C. Trautwine, 3rd, upon the resistance offered by water meters to the flow of water through them, a field of investigation until now little cultivated.

The great obstacle in the matter of the measurement of the flow of water appears to be the difficulty of determining a most im-

portant element in the resistance. It is too common to assume that the resistance in a channel is mainly due directly to the friction of the water upon the wetted perimeter, and, in formulas of the Chezy type, the quantity "R," the hydraulic radius, as it has been called, is intended to bring into the computation the frictional resistance of the surfaces of the channel or pipe. As a matter of fact, much of the resistance is due to what Professor Johnson has called "the internal work of the water," being the swirls and eddies in the body of the stream, undoubtedly indirectly due to the character of the surface of the channel, but not altogether analagous to ordinary frictional resistance. The effect of this internal work is well shown in the resistance produced by changes in the diameter of a smooth surfaced channel, an enlargement and contraction to the original dimensions producing eddies which absorb energy and create resistance, but which cannot be measured or formulated in any practical manner. It is doubtless due to such resistances, varying as they do in nearly all experimental tests, that many conflicting results are due, and until some method is found of including such disturbances in the observed data, the construction of a satisfactory formula, with constant coefficients and exponents can hardly be expected.

The New Edison Storage Battery.

EVER since the practical development of the lead plate accumulator it has been found to be possessed of two important and opposing properties, one, great usefulness as a means of enabling energy to be carried from place to place, and utilized while in transit, the other, excessive weight, seriously interfering with its use in motor vehicles and similar constructions in which portability is essential. It is not surprising therefore, that, along with the efforts which have been made to increase the efficiency and life of the storage battery, the question of reduction in weight has been considered one of prime importance. These considerations give especial interest to the paper of Dr. A. E. Kennelly, recently presented before the American Institute of Electrical Engineers, describing the new form of storage battery of Mr. Edison.

Referring first to the present forms of lead battery, in which lead peroxide is the depolarizing substance, it is found that in general practice the storage energy per unit mass is from four to six watt hours per pound of battery. That is to say, a battery weighs from 125 to 186 pounds per horsepower hour at its terminals; or, if its stored energy available at terminals were all expended in gravitational work, a battery could raise its own weight through a vertical distance of between two and three miles. These figures represent the average practice, although it was stated at the meeting that efficiencies of practically double this had been obtained in certain cases. Certain, it is, however, that the weight of the lead storage battery has been the greatest impediment to its more extensive introduction.

"While it is possible to increase the energy per unit mass by making the electrodes very light, yet this is always found to be followed by a very heavy deterioration.

"Many attempts have also been made to perfect storage cells of the alkaline-zincate type, but the great difficulty of depositing zinc in coherent form from the solution, as well as the lack of a depolarizer that shall be insoluble in the electrolyte, has stood in the way of this cell's success.

"Mr. Edison set himself the task of finding a cell which should possess the following advantages:

"1. Absence of deterioration by work.

"2. Large storage capacity per unit of mass.

"3. Capability of being rapidly charged and discharged.

"4. Capability of withstanding careless treatment.

"5. Inexpensiveness.

"He believes that the cell here shown may claim these advantages in a very satisfactory degree.

"The negative pole or positive element, corresponding to the zinc of a primary cell or the spongy lead of a secondary cell, is iron. The positive pole or negative element, corresponding to the carbon of a primary cell or lead peroxide of a secondary cell, is a superoxide of nickel believed to have the formula NiO_2. The cell is therefore a nickel-iron cell, a name which suggests the structural material—nickel-steel.. The electrolyte is potash; *viz.*, an aqueous solution containing from 10 to 40 per cent.

by weight, but preferably 20 per cent. of potassium hydroxide, the freezing temperature of which is 20 degrees below zero Fahrenheit or—30 degrees centigrade."

Comparing this cell with the lead battery, it appears that the storage capacity per unit of mass is 14 watt-hours per pound, as against six for the old type.

"Expressing the same statement in another way, the weight of battery per unit of electric energy at terminals is 53.3 pounds per electrical horse-power-hour or 32.4 kilos per kilowatt-hour. Or the battery gives energy at its terminals sufficient to lift its own weight through a vertical distance of approximately 7 miles or 11.26 kilometres. The mean normal discharging power-rate per unit mass of total cell is 4 watts per pound or 8.82 watts per kilo. Corresponding to a normal discharge period of three and one-half hours. The cell may, however, be discharged at a relatively high rate, in approximately one hour. Corresponding to a discharging power-rate per unit of total cell mass of 12 watts per pound or 26.46 watts per kilo. Charging and discharging rates are alike. That is to say, the cell may be charged at the normal rate in three and one-half hours; or, it may be charged at a relatively high rate in one hour, with no apparent detriment beyond a somewhat lowered electrical charge efficiency. In other words, the cell does not appear to be injured by over-charging or discharging, and only suffers in electrical efficiency under such treatment."

Physically speaking, the call may be termed an oxygen lift. Charging pulls the oxygen away from the iron and delivers it temporarily to the nickel. The condition is then stable, until the circuit of the cell is completed. Discharge then allows the oxygen to fall back from the nickel to the iron with the natural affinity of iron and oxygen. The potash solution suffers no change, but acts merely as a carrier of the oxygen, while in the case of the lead peroxide cell the solution becomes gradually changed from dilute sulphuric acid to plain water. There is, therefore, in the new cell opportunity to reduce the weight by diminishing the quantity of solution in addition to the much less weight of plates required.

Details of the mechanical structure of the cell and diagrams of its performance were given, and there is no doubt that Mr. Edison has accomplished all that he set out to perform in the five points stated above.

One immediate feature which should appear with its introduction should be a marked increase in the use of electrically propelled vehicles, since with the lighter battery the radius of action will be practically doubled for the same weight, or for moderate runs much lighter vehicles will become practicable.

Electricity in Mountain Mines.

A RECENT paper read before the American Institute of Electrical Engineers by Mr. F. W. Brady upon the subject of electric machinery in difficult mining countries contains much matter which should be read and appreciated by manufacturers who hope to participate in the valuable and important business of supplying such apparatus.

In the first place it should be fully understood that such material must be capable of separation into sections small enough to be carried over burro trails several miles in length and often of more than ordinary difficulty. An example of misplaced labor is given in the case of a cast iron drum of 4½ by 5 feet, weighing 3,500 pounds being transported by rail for more than 1,000 miles, only to find a permanent resting place within a few miles of the mine where it was intended to have been used.

Another point demanding more careful attention than is generally given is the amount of power available. Water power is generally over-estimated, and care should be taken to get reliable data, extending over as many teays as possible, or the variable character of mountain streams may prove most deceptive. The report of the constructing engineer should be very complete, not only regarding the water power, but also concerning the conditions in the mine, the possible methods of transportation, special requirements in design of apparatus, maximum weight and dimensions of parts, topography of the district for pipe lines, etc., etc.

It must not be forgotten that air compressers operated in high altitudes lose a portion of their capacity, owing to the rarefied condition of the atmosphere, while electrical apparatus suffers from lightning. Electrical storms are of frequent occurrence

in the mountains, and heavy discharges sometimes occur from the lines in clear weather, so that especial attention should be paid to lightning arresters.

Mr. Brady gives a detailed account of the equipment of the American Nettie Gold Mine, at Ouray, Colorado, this being a good example of an installation in which all the mine machinery and most of the materials for the transmission line were transported from the railway over a burro trail. In this interesting description will be found examples of the difficulties which have to be overcome, and a study of this and other similar installations should form excellent preliminary training for those designing not only electrical, but also general machinery for use in places where, notwithstanding the difficulties of transport and operation, power and transmission plants are most valuable investments.

The Multiple-Unit Tramway System.

In a recent issue of the *Street Railway Journal* there appears a paper by Mr. Frank J. Sprague, giving a general account of the multiple-unit system for operating trains of electric cars, and in connection with it is also given an article by Mr. George H. Hill containing some interesting notes on the history and development of the system.

In view of the importance of the subject and its possible bearing upon the wider one of the use of electric driving on main-line railways, some abstract of these papers is here given, and the interested reader is referred to the originals for further details.

The use of electricity for tramway traction naturally was at first limited to single cars, and even at the present time, one motor car and one trailer is about all that is considered advisable to employ on surface roads in city streets. With the extension of electric traction to elevated railways, however, the control of the right of way, and the absence of grade crossings permitted the use of trains of several cars, and as such roads were originally usually operated by steam locomotives the practice has more or less become assimilated to that of main steam railways.

While the train is a necessity of the use of the travelling power house known as the locomotive, the different conditions under which electric traction is operated make other arrangements possible, since the mechanism for the application of the motive power is the only portion carried upon the cars, and the power generation is conducted at one or more stationary power houses at convenient locations.

At the same time the construction and operation of steam roads according to the train system, and the development of such transportation business entirely on the train basis has made it practically necessary for electric traction, from a commercial standpoint, to be operated upon the principle of trains, if it is to supersede steam, and to meet this idea Mr. Sprague developed the "multiple unit" system which he has recently put into successful operation on the South Side Elevated Road in Chicago.

It is important that a distinction should be made between distributed motor control and multiple-unit operation. The terms are not synonymous, nor need they be operated by similar methods. The former may represent simply the physical shifting in location of a part of the motors constituting a train equipment. The latter is a generic method of train make-up and operation in which power-controlled units capable of independent operation can be aggregated into a train, with or without other units partially equipped, and all the units be simultaneously controlled and operated from one or more of them.

The details of the Sprague system cannot be discussed without numerous diagrams of the apparatus and connections, and such are very fully given in Mr. Sprague's paper, referred to above. It must here suffice to say that it consists of two main motors on each fully-equipped car, with three principal switches for determining the connections and the flow of current. There is a reverser, for changing the armature connections of the two motors, a rheostat for varying the resistance in the circuit with them, and a motor switch for effecting the series in parallel relation.

These main switches are primarily controlled from a masters' switch on each platform of any equipped car, through a train line and suitable relays and a pilot motor. Such completely equipped cars can be connected together to form trains, with or without train line cars, these latter having only train-cable couplers and jumpers, unless it

is desired to control an equipment from them, in which case master switches can be added.

The platform switch circuits, the local operating or relay circuits, and the train-line circuits are joined together by switches which permit such independent connection on each car that controllers on any car can be operated from the master switch on its car no matter how a train is made up, without the controllers on other cars being affected, or the controllers on as many cars can be operated from the master switch on another car without the controller on that car being operated, as well as the normal operation of all controllers from any master switch.

The success which has attended the operation of the multiple control system in Chicago, and the adoption of the system upon the Manhattan Elevated Railroad in New York is sufficient evidence of the practicability of the system, and the operation of these roads is sufficiently similar to that of the ordinary steam railways, that this may rightly be termed the entering wedge in the introduction of electric driving on steam railways.

Mercury Vapor Lamps.

At a recent conversation held by the American Institute of Electrical Engineers, Mr. Peter Cooper Hewitt made a most interesting exhibit of mercury vapor lamps, and from a subsequent communication published in the *Electrical World and Engineer* gave some notes upon the subject.

The lamps shown by Mr. Hewitt consisted of glass tubes of two to five feet long and ¾ to 1½ inch in diameter, containing vapor of mercury, and fitted with terminals at each end for connection to the electric circuit. These tubes, upon the passage of an electric current, emitted a brilliant light, ranging from 500 to 1,000 candle power producing a most effective display.

While there is some resemblance in construction between these mercury lamps and the well-known Geissler tubes, there are also important differences. The Geissler tube contains a rarefied gas, and is traversed by an alternating high-tension current from an induction coil, the light varying in color according to the gas and being usually stratified and rather feeble in illuminating power.

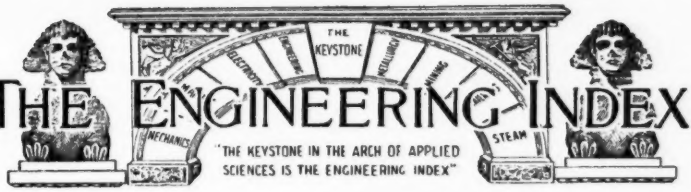
The mercury lamp, on the contrary, employs a low voltage continuous current, and instead of showing a feeble light the interior of the tube is filled with incandescence.

Mr. Cooper's exhibit was intended to show several facts connected with this form of light, especially its high efficiency and to illustrate the laws of conduction of the electric current by gases and vapors. For this purpose the lamps exhibited were shown in connection with standard Weston voltmeters and ammeters and from the readings of these instruments curves have been plotted showing the performances.

In regard to the relation of the voltage to the gas-carrying current, it appears that the volts vary directly as the length and inversely as the diameter of the tube, this not being exactly borne out by the experiments, but with variations probably due to explainable causes. The relation of current to resistance was also investigated, and the result showed that the voltage tending to remain constant the resistance varied inversely with the current.

The efficiencies of the lamps are given for the different sizes exhibited, the results being tabulated and plotted in the form of curves. For the large lamp, with tube 54 inches long and 1 inch in diameter the candle-power ranged from 840 to 1050, with a corresponding efficiency of 0.43 to 0.65 watts per candle. The next size, 32 inches long by ¾ inch diameter, showed a somewhat lower efficiency, requiring 0.78 watts per candle at 630 candles.

That such high efficiencies can be obtained by use of direct currents as are ordinarily available, in lamps having intensities as high as 500 to 1,000 candle power is noteworthy. Such lights would be closely comparable with arc lamps for practical lighting purposes, were it not for the fact that the color is so far objectionable. The light of the mercury vapor appears to be almost entirely deficient in red rays, the small portion of red which can be detected by the spectroscope being insufficient to give a satisfactory illumination when screens are used. It has been suggested that the use of vapor of other metals in connection with that of mercury may so modify the color of the light as to enable this difficulty to be overcome, in which case the incandescent tube may take an important place in commercial lighting.



THE ENGINEERING INDEX

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. *w.* San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Drawbridge.

Replacing a Passaic River Drawbridge. Describes the method of floating away a 220½-ft. swing span and replacing it by a heavier span also floated into place. 700 w. Eng Rec—May 25, 1901. No. 41215.

Early Bridge.

The First Iron Railway Bridge. An illustrated account of a bridge built in 1823 for the Stockton and Darlington Railway. 700 w. Engr, Lond—May 10, 1901. No. 41038 A.

East River.

The Suspended Span of the New East River Bridge, New York. Illustrated description of the stiffening trusses of this bridge and the unique details of their support at the towers. 1600 w. Eng Rec—May 4, 1901. No. 40722.

Erection.

Construction Methods in Civil Engineering. Frank W. Skinner. Read before the Applied Science Soc. of McGill Univ. Introductory remarks on the technical training given civil engineers, with illustrations of typical methods of bridge erection. 6400 w. Can Engr—May, 1901. No. 40911.

Highway Bridge.

Highway Bridge of 406-Ft. Span; Hamilton, O. Illustrated detailed description of the bridge known as the Columbia bridge, across the Miami River, notable not only for its length, but also in many points of its construction. 2000 w. Eng News—May 23, 1901. No. 41201.

Hudson River.

The Problem of All-Rail Transportation Across the Hudson River at N. Y. City. C. W. Buchholz. Abstract of a paper read before the N. Y. R. R. Club, with editorial, and discussion. On the need and the problems connected with North River bridges and tunnels. 7900 w. Eng News—May 16, 1901. No. 40948.

The Problem of Providing an All-Rail Connection, across the Hudson River, between the City of New York and the Railroads Terminating on the Jersey Shore. C. W. Buchholz. A consideration of the various plans suggested, with general discussion. 8800 w. N. Y. R R Club—April 18, 1901. No. 40970.

Which Is the Best Site for a Hudson River Bridge at New York? A discussion of the conditions and locations, favoring the Fifty-ninth street site. 1800 w. R R Gaz—May 17, 1901. No. 40952.

Kinzua Viaduct.

The Kinzua Viaduct of the Erie Railroad Company. Continued discussion of paper by C. R. Grimm. 4400 w. Pro Am Soc of Civ Engrs—May, 1901. No. 41-269 E.

Military Bridges.

Military Bridges. Illustrates and describes methods of construction. 1900 w. Sci Am Sup—May 4, 1901. No. 40747.

Piers.

Piers of Midland Railway Bridge, Shubenacadie River, South Maitland, Nova Scotia. George E. Thomas. Illustrated description of the difficulties encountered and overcome in the building of these pneumatic piers. 6000 w. Jour W Soc of Engrs—April, 1901. No. 40982 D.

Reconstruction.

The Redheugh Bridge. Illustrated description of the recent reconstruction of this bridge between Newcastle and Gateshead. 800 w. Engng—May 10, 1901. No. 41044 A.

The Substructure of Glasgow Bridge Over the Missouri River. H. P. Boardman. An illustrated description of the reconstruction of this bridge, with an interesting discussion, in which Gen. W. Sooy Smith reviews the history of the old bridge, which was the first great steel bridge ever built. 12000 w. Jour W Soc of Engrs—April, 1901. No. 40979 D.

Rhine.

The New Bridge Across the Rhine at Worms (Nouveau Pont sur le Rhin à Worms). M. Seurat. With full details and views of the structure. There is one span of 388 ft. and two 351 ft., with braced bow-string girders. 2000 w. 1 plate. Génie Civil—May 11, 1901. No. 41106 D.

Swing Bridge.

Turntable and Operating Mechanism of a 360-Foot Swing Bridge. Illustrated description of a single-track swing span having a number of special features in the turntable and latching apparatus. 1200 w. Eng Rec—May 18, 1901. No. 40963.

CONSTRUCTION.

Australia.

Public Works in Australia (Les Grands Travaux Publics en Australie). A. Mahoudeau. With especial reference to Western Australia, including the harbour of Fremantle and the works in connection with the mines of Kalgoorlie. 2500 w. Revue Technique—April 10, 1901. No. 41111 D.

We supply copies of these articles. See introductory.

Brickwork.

Architectural Brickwork From the Standpoint of a Constructing Engineer. John Stephen Sewell. Discusses the necessary features of good brick work, the heads of the bricks, the joints, including the mortar, and the bond. 7000 w. Arch Rev—May, 1901. No. 41200 D.

Building Construction.

Progress of Work at the United States Naval Academy. J. P. Carlin. Illustrated description of the new Naval Academy buildings at Annapolis and the methods of constructing them; the notes on the carrying power of piles, methods of handling heavy masonry, and the construction of concrete sea walls are especially full. 4000 w. Eng Rec—May 11, 1901. No. 40872.

The Montgomery Ward & Company Building, Chicago. Illustrated description of a 12-story steel-cage office building with a tower 390 ft. high. The structural details of the latter, the special system of fire-proofing and an unusual system of open elevator shafts are described. 2200 w. Eng Rec—May 25, 1901. No. 41212.

Concrete Masonry.

Construction of Concrete Masonry of a Canal Dock on the Eastern Section of the Illinois & Mississippi Canal. Jas. C. Long. Illustrates and describes the construction work, materials used, tests, etc. Also discussion. 5000 w. Jour W Soc of Engrs—April, 1901. No. 40980 D.

Dry-Dock.

A 10,000-Ton Balanced Sectional Dry-Dock. William T. Donnelly. Reviews the past history of the docking of vessels, and gives an illustrated detailed description of the largest timber floating dry-dock that has ever been constructed. 5500 w. Eng News—May 2, 1901. No. 40737.

Exposition.

Notes on the Paris Exposition, 1900 (Einiges von der Pariser Austellung, 1900). A. Weber. With especial reference to the building construction of various nations. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—April 26, 1901. No. 41136 B.

Piers.

See Civil Engineering, Bridges.

Steel-Work.

Constructional Steel-Work as Applied to Building. Archibald D. Dawnay. Read before the Brit. Soc. of Archts. Historical review, with some discussion of constructive questions. 9600 w. Builder—April 20, 1901. No. 40633 A.

Struts.

The Strength of Struts. R. H. Smith. A review of a paper on the "Practical Column" by J. M. Moncrieff in the March, 1900, number of the Pro. of the Am. Soc. Civ. Engrs. 2500 w. Engr, Lond—April 19, 1901. Serial. 1st part. No. 40649 A.

Tunnel.

The Proposed Irish Channel Tunnel. An account of a project to connect England and Ireland by tunnel under the Irish Channel. 3300 w. Eng News—May 23. 1901. No. 41203.

CANALS, RIVERS AND HARBORS.

Australia.

See Civil Engineering, Construction.

Breakwater.

The New Stone Breakwater at Buffalo, N. Y. Illustrates and describes a new form of breakwater now under construction, built of stone, with a gravel hearting; also the methods of working, machinery used, the material, etc. 6000 w. Eng News—May 16, 1901. No. 40944.

Bremerhaven.

The Extension Works at the Port of Bremerhaven (Les Travaux d'Extension du Port de Bremerhaven). A. Boudon. An illustrated account of the new docks and power station at this important German port on the Weser. 2500 w. 1 plate. Génie Civil—April 20, 1901. No. 41100 D.

Canal Problems.

American Canal Problems, with Special Reference to the State of New York. Robert E. Horton. Considers a waterway to the Great Lakes a national question, rather than sectional. The problem of connecting the Atlantic and Pacific is regarded as of first importance, and the Great Lake outlet of second. The possible solutions of the latter are discussed. 3800 w. Marine Engng—May, 1901. No. 40763 C.

Chicago.

Schemes Suggested by the Expert Commission for the Improvement of the Chicago River. An explanation of the three schemes, with estimates. 2000 w. Eng News—May 2, 1901. No. 40741.

Currents.

The Currents in the Gulf of St. Lawrence. Summary from a recently issued pamphlet, giving an explanation of the hydrography of the gulf. 2400 w. Nature—April 18, 1901. No. 40628 A.

Dam Failure.

The Washout of a Dam at Middlefield, Mass. M. J. Gibbons. Illustrated description of a heavy earth and masonry dam destroyed by a flood over its crest, which occurred through inability to operate waste gates. 1000 w. Eng Rec—May 4, 1901. No. 40726.

Delaware.

The Shoaling of the Delaware. Plan to keep the channel deep enough to maintain

navigation between Philadelphia and the sea. 1100 w. Naut Gaz—May 23, 1901. No. 41220.

Dredgers.

Smit and Sons' Dredgers. Illustrated description of a dredge, and its operation, in use in connection with the Dublin Harbor improvements. 1300 w. Engng—May 3, 1901. No. 40846 A.

Exposition.

Hydraulic Engineering at the Paris Exposition (Der Wasserbau auf der Pariser Weltausstellung). M. Paul. A review of the exhibits relating to canals, river regulation, and similar work, arranged by nationalities. Serial, Part I. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—April 19, 1901. No. 41135 B.

Isthmian Canal.

The Isthmian Canals. Extracts from the lectures of Mr. Bunau-Varilla, discussing various elements which must be considered in deciding on the relative merits of the Nicaragua and Panama routes. 2300 w. R R Gaz—May 24, 1901. No. 41230.

Mississippi.

Are Flood Heights Increasing in the Lower Mississippi River? W. J. Hardee. Condensed from a paper read before the Louisiana Engng. Soc. in discussion of the paper by L. W. Brown, in disproof of the conclusions reached. 6200 w. Eng News—May 23, 1901. No. 41206.

A Topographical Survey of the Reservoir System at the Headwaters of the Mississippi River. W. C. Lemen. Gives briefly the history of the steps leading to the creation of this reservoir system, and a description of the survey. 3300 w. Technograph, No. 15—1900-1901. No. 40996 D.

Reservoirs and the Control of the Lower Mississippi. Maj. C. McD. Townsend. Discussion of a paper on this subject by James A. Seddon. 6400 w. Jour W Soc of Engrs—April, 1901. No. 40981 D.

Nile.

The Nile Irrigation Works. An illustrated account of the work being done at a cost of $25,000,000. 1200 w. Sci Am—May 4, 1901. No. 40743.

Waterways.

Administration, Construction, and Operation of New Waterways in Austria (Verwaltung, Bau, und Betrieb der zu Erbauenden Wasserstrassen in Oesterreich). Prof. A. Oelwein. A review of the work upon the Danube-Elbe canal, the Danube-Oder canal, and other waterways aggregating more than 1,000 miles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—April 19, 1901. No. 41134 B.

MATERIALS.

Asphalt.

The Municipal Asphalt Plant at Winnipeg, Manitoba. R. N. Ruttan. On the cost of the plant and its operation. 1500 w. Am Gas Lgt Jour—May 6, 1901. No. 40783.

Building Stones.

The Building Stones and Marbles of Ireland. An illustrated article, giving information concerning the stone deposits, and development of the quarries. 2300 w. Stone—April, 1901. No. 40972 C.

The Building Stones of London. Summary of an article in *The Quarry*. The older structures used material of the limestone class, because of the great expense in working the harder varieties. Gives information relating to their wearing qualities, modern appliances for quarrying and working have caused granite to be used for more recent buildings. 3000 w. Stone—April, 1901. No. 40973 C.

Cement.

A Historical Sketch of Slag Cement. William Kendrick Hatt. From a paper before the Indiana Soc. of Engrs. An elementary statement of the nature and properties of slag cements. 2200 w. Munic Engng—May, 1901. No. 40684 C.

Effect of Different Methods of Molding Upon the Strength of Cement. Ira O. Baker. Reports the results of experimental tests made to compare methods. 1000 w. Technograph, No. 15—1900-1901. No. 41004 D.

The Portland Cement Industry in New York. Edwin E. Eckel. Briefly states the early history of the industry, and reviews the plants and materials. 6000 w. Eng News—May 16, 1901. No. 40950.

Concrete.

The Production of Concrete Under New York State Specifications. Discussion of the requirements most likely to ensure a uniform quality of cement, thorough mixing of the cement and sand, and the most economical proportions of mortar and stone. 1500 w. Eng Rec—May 11, 1901. No. 40866.

Estimating.

Tables for Estimating Amount and Cost of Materials and Labor for Buildings. Louis F. Brayton. Presents a method given by the writer in a thesis for the degree of Bachelor of Science in Architectural Engineering. 900 w. Technograph, No. 15—1900-1901. No. 41006 D.

Fire-Resisting.

The Results of Some Tests with Fire-Resisting Materials. Ellis Marsland. Read before the Soc. of Archts., London. Account of tests and experiments conducted by the British Fire Prevention Committee. 4500 w. Archt. Lond—May 3, 1901. Serial. 1st part. No. 40861 A.

Iron Protection.

Practical Experience with Rust Preven-

tion (Praktische Erfahrungen über Rostschutzmittel). Dr. T. Koller. A discussion of the action of the atmosphere upon metallic structures, describing the composition of numerous protective coatings. 3500 w. Glaser's Annalen—April 15, 1901. No. 41117 D.

Protection of Ferric Structures. M. P. Wood. A review of notable instances of failure to protect ferric structures from corrosion, and also instances of success, with discussion of coatings generally used. 20000 w. Trans Am Soc of Mech Engs, No. 886—May, 1901. No. 41075 D.

Long Columns.

Formulas for the Resistance of Long Columns. A discussion on the assumptions at the base of various theoretical formulas for the resistance of long columns and a statement of reasons for preferring a curve based on results of tests of full size columns. 1500 w. Eng Rec—May 18, 1901. No. 40961.

The True Formula for Buckling (Die Richtige Knickformel). J. Kübler. A further contribution to this much discussed subject, with table of coefficients for the author's formula. 1500 w. Zeitschr d Ver Deutscher Ing—April 20, 1901. No. 41126 D.

Wood.

Factors Which Cause the Decay of Wood. Prof. Hermann von Schrenk. The subject is discussed under the heads of structure, chemical nature, decay, fungi, preventive measures. Ill. 5600 w. Jour Soc of Engrs—April, 1901. No. 40978 D.

MEASUREMENT.

Instruments of Precision.

A Few Instruments of Precision at the Paris Exposition of 1900. William E. Reed. Describes exhibits in this line. 4300 w. Trans Am Soc of Mech Engrs, No. 905—May, 1901. No. 41094.

Theodolite.

The Heyde Geared Theodolite (Heyde's Neuer Zahnkreis-Theodolit). W. Wojtan. The instrument is made with toothed limb, enabling very accurate and positive movements to be made; it is especially adapted for geodetic work. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—May 10, 1901. No. 41139 B.

Tripod-Heads.

Notes on Tripod-Heads, with Reference to Mr. Dunbar D. Scott's Paper on the Evolution of Mine-Surveying Instruments. John H. Harden. Discusses the improved tripod-legs and the tripod-head. 1000 w. Trans Am Inst of Min Engs—April, 1901. No. 40823 D.

Surveying.

Geological Survey Plan of Operations. Details of the arrangements made for the work of the U. S. Geol. Survey for the fiscal year 1901-1902. 3000 w. Min & Met—May 1, 1901. No. 41013.

MUNICIPAL.

Drainage.

The Drainage Plant of the City of Hanau (Die Entwässerungs Anlage der Stadt Hanau). Ad. Mertz. Illustrating and describing the arrangement of centrifugal pumps driven by direct-connected electric motors. 1000 w. Zeitschr d Ver Deutscher Ing—May 11, 1901. No. 41131 D.

Franchises.

Franchises. H. S. Cooper. An explanation of the meaning of the term, and a discussion of their value and application, as introductory to a series of articles from an equitable and business standpoint. 3000 w. St Ry Rev—May 15, 1901. Serial. 1st part. No. 40959 C.

London Streets.

The State of London Streets. T. Blashill. Discusses the condition of the London streets, and the treatment of streets in Continental cities. General discussion follows. 11000 w. Jour San Inst—April, 1901. No. 41272 F.

Ownership.

Municipal Ownership vs. Private Corporations. Thomas D. Miller. Read at meeting of the Southwestern Gas, Electric and Street Ry. Assn. Discussion of the subject, unfavorable to municipal ownership. 2500 w. Am Gas Lgt Jour—May 6, 1901. No. 40782.

Pavements.

Durability of Brick Streets. W. Blair. Reports examinations made, and considers that if the construction is good, the pavement will prove durable. 3000 w. Brick—May, 1901. No. 40785.

Paving in Boston. F. S. Gore. Describes the kind of paving generally used at the present time, giving the specifications for laying Sicilian Rock asphalt, and information about car tracks. 1200 w. St Ry Rev—May 15, 1901. No. 40958 C.

Some Experiments in Laying Bituminous Macadam. Describes some experimental sections of roadway laid in East Cambridge, Mass. 1800 w. Munic Engng—May, 1901. No. 40681 C.

Sanitation.

On the Drainage, Reclamation and Sanitary Improvement of Certain Marsh Lands in the Immediate Vicinity of Boston. William Lyman Underwood. Describes and illustrates the condition of the "Fresh Pond Marshes" as they now exist, and as they existed before certain sanitary improvements, recently made, were carried out. 3200 w. Tech Quar—March, 1901. No. 40977 E.

The Principles of Municipal Sanitation (Principien der Städtereinigung). Dr. Paul Degener. A study of the wastes of modern cities and the methods of their removal and disposal. Serial, Part I. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—May 3, 1901. No. 41138 B.

Septic Tanks.

The Antecedents of the Septic Tank. Leonard Metcalf. Treats of the evolution and antecedents of the septic tank in their bearing upon and relation to the collateral patent question and the claims being made. 5700 w. Pro Am Soc of Civ Engrs—May, 1901. No. 41268 E.

Sewage.

Discharge of Sewage from Toronto Sewers in 1900. Cecil B. Smith. Describes the method of taking a record of the flow of sewage in dry weather, to establish data on which to base the design of interceptors, trunk sewers, and disposal works. Plates and tables. 1600 w. Can Soc of Civ Engs—Adv. Proof. No. 40926 D.

Modern Methods of Sewage Purification. Information from the recent annual report of the Connecticut Sewerage Commission, concerning the experiments at Manchester, Eng. Ill. 2200 w. Munic Engng—May, 1901. No. 40680 C.

The Sewage Precipitation Works at Providence. Illustrated description of 20 concrete tanks, 5 sludge reservoirs, press house, chemical building and laboratory forming the works for the chemical treatment of the Providence sewage before it is discharged into the river. 2900 w. Eng Rec—May 4, 1901. No. 40720.

Sewers.

Flow in the Sewers of the North Metropolitan Sewerage System of Massachusetts. Continued discussion of paper by Theodore Horton. 500 w. Pro Am Soc of Civ Engrs—May, 1901. No. 41270 E.

Rapid Transit and Sewerage. An account of the changes in sewers in New York, made necessary by the building of the underground road, and the difficulties encountered. 1000 w. Fire & Water—April 27, 1901. No. 40598.

Streets.

Parking Wide City Streets. Robert L. Johnson. An account of work done in the city of Columbus, Georgia, for beautifying and improving the streets. Ill. 1200 w. Eng News—May 16, 1901. No. 40949.

WATER SUPPLY.

Aqueducts.

The Torresdale Conduit at Philadelphia. Illustrated description of a 10½-ft. aqueduct 13,815 ft. long, to discharge 300,000,000 gals. per day. 2000 w. Eng Rec—May 18, 1901. No. 40962.

The Weston Aqueduct of the Metropolitan Water-Works, Boston. Alfred D. Flinn. Illustrated description of aqueduct 13½ miles long, with a daily capacity of 300,000,000 gals., and having a number of special features in concrete construction. 3800 w. Eng Rec—May 4, 1901. No. 40721.

Bacteria.

Changes That Take Place in the Bacterial Contents of Waters During Transportation. George C. Whipple. An account of experimental investigations, the results of which are of practical importance to the water analyst. 2300 w. Tech Quar—March, 1901. No. 40974 E.

Cincinnati.

The New Water Supply of Cincinnati, O. Description of the purification plant, land tunnel, city pumping station, etc., of the works under construction at the village of California, about seven miles above the city. 2500 w. Eng News—May 23, 1901. No. 41202.

Electrolysis.

See Gas Engineering.

Filtration.

A Filtration Plant at Albany, N. Y. William O. Webber. Brief illustrated description of the plant established at the new intake. 1600 w. Trans Am Soc of Mech Engrs, No. 888—May, 1901. No. 41076.

The Water Purification Works of the East Jersey Water Company of Little Falls, New Jersey. George W. Fuller. Illustrated description of a plant for purifying 40,000,000 gals. daily by coagulation and mechanical filtration. The entire plant is built of concrete, the filter tanks being square in order to economize space. 2000 w. Eng Rec—May 11, 1901. No. 40868.

Water-Works of the Catholic Protectory of Philadelphia. Charles G. Darrach. Illustrated description of a slow sand filter remarkably compact in arrangement, with notes on pumping engines driven by compressed air from a central plant a quarter of a mile distant. 600 w. Eng Rec—May 11, 1901. No. 40871.

London.

The New Works of the Southwark and Vauxhall Water Company. Illustrated description. 2000 w. Jour Gas Lgt—May 7, 1901. No. 40922 A.

Management.

Efficient Management and Maintenance of Water-Works Owned by Municipalities or Private Corporations. Benjamin L. Williams, Jr. Urges the importance of attention to details, the installation of meters, etc. 1200 w. Munic Engng—May, 1901. No. 40682 C.

Reservoir.

The Upper Belmont Reservoir at Phila-

delphia. Illustrated description of a two-basin 72,000,000-gal. reservoir, noteworthy for the piping details and the method of lining the banks and bottoms. 2200 w. Eng Rec—May 25, 1901. No. 41217.

Submerged Pipe.

Submerged Pipe Crossings of the Metropolitan Water Board. Caleb Mills Saville. A description of some of the methods employed. Ill. Also discussion. 10300 w. Jour Assn of Engng Socs—March, 1901. No. 40990 C.

The New Supply of the Cedar Rapids Water Company, Iowa. Illustrated description of the method of laying 864 ft. of 30-in. submerged suction main, with note on a new form of connecting well. 450 w. Eng Rec—May 25, 1901. No. 41214.

Water Meters.

The Cost of Installing a Water Meter System. A. L. Holmes. A paper read before the Mich. Engrs. Soc. Discusses the average cost, and shows that a metered supply will save more than the cost of a new pumping station which would otherwise be needed. 3000 w. Munic Engng—May, 1901. No. 40683 C.

MISCELLANY.

Chemistry.

Chemistry in Its Relations to Engineering. Frank Clowes. Abstract of the "James Forrest" lecture delivered before the Inst. of Civ. Engrs. Shows the advantages engineers have derived from chemical coadjutors, illustrating by instances from various fields. 3000 w. Engr, Lond—April 26, 1901. No. 40812 A.

Explorations.

Engineering Explorations in Montana and Elsewhere in the Rocky Mountains. Francis W. Blackford. Presidential address before the Montana Soc. of Engrs. A review of the explorations, beginning with the expedition of Lewis and Clarke, in 1804. 5800 w. Jour Assn of Engng Socs—March, 1901. No. 40992 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Combination.

Simultaneous Use of Telephone and Hughes System on Telephone Lines (Gleichzeitiger Vernsprech und Hughesbetrieb auf Vernsprech-Verbindungsanlagen). O. Jentsch. A description of the method used between Berlin-Vienna and other cities for the use of the Hughes telegraph system in connection with telephone lines. 1800 w. Elektrotech Zeitschr—April 18, 1901. No. 41164 B.

Printing Telegraph.

The Murray Page-Printing Telegraph. Illustrates and describes this ingenious invention. The fundamental principle is the use of a perforated tape divided into half-inch spaces, each representing a character. This is run through a printer, whose operation is similar to the automatic piano. 1500 w. Sci Am—May 4, 1901. No. 40742.

Signalling.

Recent Developments in Electric Signalling. Reviews the progress made during the last few years in wireless telegraphy; also important improvements in wire-using devices, discussing the Pollak-Virag system, Dr. Pupin's system, and others. 4000 w. Nature—May 2, 1901. No. 40841 A.

Space Telegraphy.

A New Theory of Wireless Telegraphy. Ideas advanced by M. Rudolf Blochmann, in the *Revue Générale des Sciences,* which give light on points not previously explained. 700 w. Elec Rev, Lond—May 17, 1901. No. 41245 A.

Syntonic Wireless Telegraphy. Guglielmo Marconi. Describes fully the successful efforts of the author to tune or syntonise the wireless system, and the recent progress of this system. Ill. 10000 w. Jour Soc of Arts—May 17, 1901. No. 41237 A.

Wireless Telegraphy. S. M. Kintner. Briefly explains the three forms of wireless telegraphy under the heads of conduction, induction, and radiation, and discusses the particular points of the various theories advanced and the development of the systems in use. Ill. 10000 w. Pro Engs' Club of W Penn—March, 1901. No. 40909 D.

Switchboard.

The Switchboard of the German Post Office Telegraph of 50 Double Conductors (Der Klappschrank für 50 Doppelleitungen M. 99 der Deutschen Reichs-Postverwaltung). Giving details of the standard board, plugs, and wiring. 1200 w. Elektrotech Zeitschr—May 2, 1901. No. 41172 B.

Telephone Exchange.

Modern Telephone Engineering. Kempster B. Miller. Read before the N. Y. Elec. Soc. A discussion of engineering problems arising in planning a telephone exchange and a description of methods and means employed in modern practice.

2700 w. Elec Rev, N. Y.—May 4, 1901. Serial. 1st part. No. 40771.

Telephone Rates.

Railroads and Telephone Rates. An editorial statement of the situation of the Bell Companies and the Independents and the competition that would probably result in case the latter united with the railroad interests. 2200 w. R R Gaz—May 24, 1901. No. 41232.

Telephones.

The Acoustic and Electric Constants of the Telephone. Max Wien. Discusses whether in the telephone itself there are causes for the different transmission of different notes, thus affecting the distinctness of speech. 2500 w. Elect'n, Lond—May 10, 1901. No. 41018 A.

Telephony.

Improvements in Telephony (Neuerungen auf dem Gebieteder Telephonie). H. Zopke. With especial reference to improvements in switchboards; also containing an account of the Poulsen telephonograph. 3000 w. Zeitschr d Ver Deutscher Ing—April 20, 1901. No. 41-125 D.

The Engineering Side of Telephone Work on the Pacific Coast. An illustrated detailed description of the exchange equipments and operation. 2000 w. Elec Wld & Engr—April 27, 1901. No. 40599.

The New Equipment of the Sandusky Telephone Company. A. E. Dobbs. History and illustrated description. 2200 w. Elec Rev, N. Y.—May 4, 1901. No. 40773.

DISTRIBUTION.

Alternating Currents.

The Solution of Typical Branched Alternating Current Circuits by Complex Quantities. Harold B. Smith. Gives problems designed to illustrate the application of the complex quantity method of calculation. Mathematical. 1600 w. Jour Worcester Poly Inst—May, 1901. No. 41067 C.

Converters.

Frequency Converters. A. S. McAllister. Describes a recently developed method for changing the lower frequency to a value suitable for lighting purposes by the use of "frequency converters," which constitute a special adaptation of induction motors as secondary circuit generators. 1500 w. Elec Wld & Engr—May 11, 1901. No. 40886.

Niagara.

The Distribution and Conversion of Received Currents. Henry Gordon Stott. A brief description of the apparatus and lines generating, transforming and conveying the current from Niagara Falls to the Terminal House at the city limits of Buffalo, with the more important and novel features in the distribution and conversion. Ill. 6000 w. Trans Am Inst of Elec Engrs—April, 1901. No. 40983 D.

Short Circuits.

A Simple Method of Locating a Short Circuit Between Electrical Conductors. Arthur B. Roe. Illustrates and describes a method based upon the law of induction. 1000 w. Am Elect'n—May, 1901. No. 40620.

Transformers.

Circular Diagram for Special Cases of Transformers (Kreisdiagramme für Specielle Fälle des Allgemeinen Transformators). K. Kuhlmann. An examination of the Ossanna diagram, with applications to practical examples showing the agreement of results with those obtained by computation. 4000 w. Elektrotech Zeitschr—April 18, 1901. No. 41163 B.

Switch for Reducing the Loss in Unloaded Transformers (Schaltvorrichtung zur Vermeidung des Leerlaufstromes Unbelasteter Transformatoren). Ph. Scholtes. An illustrated account of the Schuckert device for disconnecting the primary coil when unloaded, as used by the Nuremberg Electric Station. 1500 w. Elektrotech Zeitschr—April 25, 1901. No. 41167 B.

ELECTRO-CHEMISTRY.

Accumulators.

Edison's New Accumulator. Information based upon Edison's British specification. Description of the battery is given with critical remarks. Ill. 1100 w. Auto Jour—May, 1901. No. 41241 A.

Some Notes on the Copper-Cadmium Storage Battery. J. K. Pumpelly. Gives the history of this type of battery. 700 w. W Elect'n—May 4, 1901. No. 40835.

The Edison Storage Battery. Dr. A. E. Kennelly. A statement of the method whereby the weight-efficiency of the accumulator has been increased two and one-half times. Also interview with the inventor. 5500 w. Elec Rev, N. Y.—May 25, 1901. No. 41265.

Assaying.

The Electrolytic Determination of Copper. Thorn Smith. A description of a laboratory method of electrolytic assay. 1700 w. Eng & Min Jour—May 25, 1901. No. 41224.

Bleaching.

Bleaching at the Anode by Electro-Chemical Action. Woolsey McA. Johnson. An illustrated description of experimental work, giving the details of the process. 900 w. Elec Wld & Engr—May 11, 1901. No. 40888.

Carbide.

The Reducing Action of Calcium Carbide (Studien über die Reduzierende Kraft des Calcium Carbides). F. v. Kügelgen. A very full account of experi-

ments with salts of lead, copper, silver, zinc, etc. Three articles, 10000 w. Zeitschr f Elektrochemie—April 11, 18, 25, 1901. No. 41178 each G.

Carbons.

Carbon in Electro-Chemical Operations. A consideration of the necessary conditions which carbons for different purposes should fulfil, and of how the process of manufactures affects the physical and mechanical qualities of the material. 3000 w. Elec Chem & Met—April, 1901. No. 40833 A.

The Development of the Artificial Carbon Industry (Die Entwickelung der Kunstkohlenfabrikation). J. Zellner. A historical review of the various processes for making carbon terminals and electrodes. 3000 w. Zeitschr f Elektrochemie—March 28, 1901. No. 41176 G.

Carborundum.

Carborundum. L. J. Gray. An account of the discovery and early development of the manufacture, describing the furnaces and their working, the appearance of the crystals, etc., with a discussion of the properties which render it so valuable. 5460 w. Engs' Year Bk, Univ of Minn.—1901. No. 40928 C.

Cells.

The Haas and Oettel Hypochlorite Cell. John B. C. Kershaw. Illustrates and describes this cell, and gives figures supporting its claims for efficiency. 1100 w. Elect'n, Lond—May 10, 1901. No. 41-017 A.

Electric Smelting.

Is the Smelting of Iron Ore by Electricity Practicable? Editorial discussion concluding that under the most favorable circumstances the cost would be several times as great as with present methods. 1500 w. Eng News—May 2, 1901. No. 40740.

Reduction of Arsenic Ores in the Electric Furnace. Carl Hering. An illustrated description of an electrical process which overcomes the objections to the usual metallurgical processes, enabling the arsenic to be extracted as a metal, and leaving the other metals concentrated in the resulting matte. 2500 w. Elec Wld & Engr—April 27, 1901. No. 40600.

Frasch Process.

The Frasch Electrolytic Process for Nickel, Cobalt and Copper Ores. Describes the method and illustrates a form of apparatus by which it may be carried out. 1200 w. Min Rept—May 9, 1901. No. 40876.

Phonograph.

A New Phonographic Principle (Ueber ein Neues Phonographisches Prinzip). W. Nernst & R. v. Lieben. The electrochemical action of a current upon an endless platinum band or revolving copper disk enables variations in current to be reproduced in a microphone. 2000 w. Zeitschr f. Elektrochemie—April 4, 1901. No. 41177 G.

An Electrochemical Phonograph. An illustrated account from the *Zeitschrift für Elektrochemie*, in which Nernst and V. Lieben describe a minute electrolytic cell, in which voice currents set up imperceptible surface variations on a moving electrode, which may be made to reproduce the vocal sounds. 1500 w. Elec Wld & Engr—April 27, 1901. No. 40601.

Reactions.

Electrochemical Action. C. J. Reed. A study of electrochemical actions, explaining the conditions necessary, the systems, kinds of electrodes, etc. 7500 w. Jour Fr Inst—May, 1901. Serial. 1st part. No. 40719 D.

Refining.

Production of Hydrogen and Oxygen for Industrial Purposes by Electrolysis. Illustrated description of the process and apparatus used. 1300 w. Engr, Lond—April 26, 1901. No. 40811 A.

Some Notes on the Electrolytic Deposition of Copper. H. Sayer and F. S. Spiers. Discusses some of the details which affect the commercial efficiency of copper refining. 900 w. Elec Chem & Met—April, 1901. Serial. 1st part. No. 40834 A.

Smelting.

Electric Furnace for Smelting Iron. Translated from *Echo des Mines et de la Metallurgie*. A resumé of the claims of a recently patented process taken out by the French Electro Metallurgical Society of Froges. 1500 w. Ir & Coal Trds Rev—April 19, 1901. No. 40639 A.

Water.

The Commercial Electrolysis of Water (Die Kommerzielle Elektrolyse des Wassers). W. Dürer. An examination of the practical difficulties met in the electrolysis of water on a large scale, with data as to cost, etc. 1000 w. Elektro-Chemische Zeitschr—April, 1901. No. 41179 G.

ELECTRO-PHYSICS.

Aluminum.

The Influence of Aluminum Upon Iron for Magnets (Ueber den Einfluss von Aluminum-Beimengungen auf die Magnetischen Eigenschaften der Gusseisens). Dr. A. Schweitzer. With tables and diagrams, showing the influence of various percentages of aluminum upon permeability and hysteresis. 1000 w. Elektrotech Zeitschr—April 25, 1901. No. 41-168 B.

Coils.

Electro-Magnetic Coils and Plungers.

Rankin Kennedy. Illustrates and describes various cases, treating the combination as an electro-motor. 1600 w. Elec Rev, Lond—April 19, 1901. No. 40635 A.

Electrical Discharges.

The Action of Magnetized Electrodes Upon Electrical Discharge Phenomena in Rarefied Gases. C. E. S. Phillips. Deals with the conditions necessary for the production of a luminous ring in rarefied gases and under the influence of electrostatic and magnetic forces. 1200 w. Elect'n, Lond—April 26, 1901. No. 40802 A.

Magnetic Attraction.

The Mechanical Forces in Dynamos Caused by Magnetic Attraction. Discussion of Mr. B. A. Behrend's paper. 3000 w. Trans Am Inst of Elec Engrs—April, 1901. No. 40986 D.

Radiant Metals.

The New Metals Polonium, Radium, and Actinium (Les Nouveaux Métaux Polonium, Radium, et Actinium). Paul Besson. A general review of the phenomena of the emission of Becquerel rays by certain metals. 3000 w. Soc Ing Civ de France—March, 1901. No. 41181 G.

The Wonderful Becquerel Ray. Edward Booth. Reviews the history of the discovery of these rays, states their characteristics, and gives general information. 2000 w. Min & Sci Pr—May 4, 1901. No. 40896.

Waves.

Electrical Wave Transmission. An illustrated account of the researches of M. I. Pupin on the transmission of electric waves over long-distance air-lines and sub-marine cables. 2000 w. Engng—April 19, 1901. No. 40642 A.

The Rapid Determination of Harmonic Waves (Methode zur Schnellen Bestimmung Harmonischer Wellen). J. Fischer-Hinnen. Deriving equations for use in plotting multiple period waves. 2500 w. Elektrotech Zeitschr—May 9, 1901. No. 41175 B.

GENERATING STATIONS.

Accumulators.

See Electrical Engineering, Electrochemistry.

Alternators.

Compounding of Alternators by Compensating Exciter. Ernst J. Berg. Explains the theory of automatic compensation, and gives an illustrated description of the method employed in the machine represented. Also editorial notes. 1900 w. Elec Wld & Engr—April 27, 1901. No. 40602.

Regulation of Alternators Under Variable Reactive Loads. George W. Redfield. Discusses the problem of alternator regulation. 3000 w. Technograph, No. 15—1900-1901. No. 41003 D.

American Stations.

Two Examples of Modern American Central Stations. Alton D. Adams. Illustrated detailed descriptions of the Atlantic Avenue Stations of the Boston Edison Company, and the arc lighting plant of the Hoboken Division of the United Electric Company of New Jersey. 5600 w. Am Elect'n—June, 1901. No. 41211.

Boston Edison System.

The Edison System in Boston—Its Development and Present Status. E. S. Mansfield. An illustrated detailed description showing the development and standing of one of the most important and successful systems in the United States, using the latest and best methods. 18500 w. Elec Wld & Engr—May 18, 1901. No. 41071.

California.

A Steam-Driven Electrical Transmission Plant. J. R. Cravath. Illustrates and describes the 22,000-volt system of the United Electric Gas and Power Company at Santa Monica, California. 1400 w. Am Elect'n—June, 1901. No. 41209.

Electricity in San Mateo County, California. C. H. Pennoyer An illustrated detailed description of the installation, and the arrangements made for generating electricity until the transmission lines could be extended to bring current from the Standard Electric Co. 2500 w. Jour of Elec—April, 1901. No. 41029.

Dynamos.

Direct-Current Dynamos in Parallel. Alton D. Adams. Suggestions of importance for their operation. Ill. 1200 w. Am Elect'n—May, 1901. No. 40626.

The Relation Between Voltage and Speed in a Shunt Dynamo. H. B. Poynder and H. E. Wimperis. The chief object of the paper is to point out two valuable deductions to be drawn from the magnetization curve by single graphical treatment. 2000 w. Engng—May 3, 1901. No. 40844 A.

Electricity Works.

Barnes and Mortlake Electricity Works. Illustrated detailed description, with account of opening ceremony. 2500 w. Elec Engr, Lond—May 3, 1901. Serial. 1st part. No. 40862 A.

Great Grimsby Municipal Electricity Works. An illustrated detailed description. 2000 w. Elect'n, Lond—May 17, 1901. No. 41243 A.

Equipment.

Recent Development in Central Station Equipment. P. Junkersfeld. Abstract of a lecture delivered before the Engng. Col. of the Univ. of Illinois. Recent develop-

ments in distributing systems and apparatus, and in other fields are briefly considered. 1400 w. W Elect'n—April 27, 1901. No. 40606.

Fulham, London.

An English Combined Central Station and Destructor Plant. Illustrated detailed description of the plant of the borough of Fulham, London. 4400 w. Elec Wld & Engr—May 4 1901. No. 40788.

Generating Set.

Generating Set of 200 Kilowatts of the Société Alsacienne (Groupe Electrogène de 200 Kilowatts de la Société Alsacienne de Constructions Mécaniques). Detailed description of tandem compound engine and continuous current generator, both made by the same company and exhibited at Paris. 1200 w. 1 plate. Génie Civil—April 27, 1901. No. 41102 D.

Hartford.

The Hartford, Conn., Electric Light Company's System. An illustrated detailed description of a modern and complete generating and distributing system, possessing features of interest. 2800 w. Elec Rev, N. Y.—May 18, 1901. No. 41058.

Heating.

Design of Pipes for Hot-Water Heating from Central Stations. Alton D. Adams. Discusses the various problems to be met and their solution. 2500 w. Elec Rev, N. Y.—May 18, 1901. Serial. 1st part. No. 41059.

Heating of Electrical Machinery Under Two Regularly Alternating Conditions of Load. Edwin Rust Douglas. The aim of the article is to show that, from a knowledge of certain constants of a machine, its performance under any unusual conditions of load may be predicted with accuracy, and to explain the determination of those constants. 2500 w. Elec Wld & Engr—May 11, 1901. No. 40889.

Load Diagrams.

A Station Load Diagram. C. R. Van Trump. Extracts from a paper read before the Nat. Elec. Light Assn. Shows a simple and effective method of tabulating station data, showing the advantage of such records. Ill. 1500 w. Elec Rev, N. Y.—May 25, 1901. No. 41264.

Rates.

The Foresee (4-C) System of Charging. L. R. Wallis. Extracts from a paper read before the Nat. Elec. Lgt. Assn. Discusses briefly various proposed plans and explains the system given the name of this title, showing how it meets the needs of the public. 2500 w. Elec Rev. N. Y.—May 25, 1901. No. 41262 A.

Regulator.

An Improved Automatic Regulator (Ein Neuer Automatischer Regulator). B. Krausse. Describing an improved automatic device for use with shunt regulators. 1200 w. Elektrotech Zeitschr—May 9, 1901. No. 41174 B.

Richmond, Va.

Electric Power Station of the Virginia Electrical Railway & Development Co., Richmond, Va. Illustrated description of one of the largest plants in the south. 1500 w. Eng News—May 2, 1901. No. 40739.

St. Croix.

The Plant of the St. Croix Power Co. of Wisconsin. Discussion of Henry Floy's paper. 5500 w. Trans Am Inst of Elec Engrs—April, 1901. No. 40987 D.

The Power Development and Transmission of the St. Croix Power Company, St. Croix, Wis. John Lycee Harper. Illustrated description of the 27-mile, 25,000-volt transmission of power for the lighting of St. Paul, part of the transmission line being underground. 3000 w. Engs' Year Bk, Univ of Minn—1901. No. 40931 C.

St. Lawrence.

Water-Power Development at Mille Roches, Ont. Illustrated description of a 4,000 H.-P. plant on the St. Lawrence, utilizing a head of only 20 to 30 ft. 2500 w. Eng Rec—May 11, 1901. No. 40869.

Short-Circuiting.

Short-Circuiting and Starting of Alternating Current Motors (Ueber den Kurzschluss und Anlauf von Drehstrommotoren). R. Goldschmidt. Deducing formulas for computing the short-circuiting for different periodicities, and magnetic conditions. 4500 w. Electrotech Zeitschr—April 18, 1901. No. 41161 B.

A Phenomenon in the Short Circuiting of Alternators (Ueber ein Phänomen bei Kurzschluss von Drehstrommaschinen). E. Rosenberg. A graphical examination of the pressure in short-circuited alternators, using solid geometry; with tables and diagrams. Two articles. 6000 w. Elektrotech Zeitschr—April 25, May 2, 1901. No. 41166 each B.

Station Economy.

Central Station Economy. The first of a series of articles calling attention to matters affecting the cost of operation. 1500 w. Elec Rev, Lond—April 19, 1901. Serial. 1st part. No. 40636 A.

Testing Generators.

Testing Direct Current Generators in the Power House. Cloyd Marshall. Points on the erection and testing, when it is necessary that it should fall upon the station engineer. 2000 w. Engr. U. S. A.—May 1, 1901. No. 40665.

Tramway Station.

See Railways and Tramways, Motive Power.

Vehicle Station.

See Mech. Engineering, Automobilism.

LIGHTING.

Arc Lamps.

Regulation and Adjustment of Arc Lamps. M. E. Chester. Describes the types of arc lamps in use, and the methods of regulation. 3000 w. Technograph, No. 15—1900-1901. No. 40994 D.

Arc Lighting.

Recent Developments in Arc Lighting. George D. Shepardson. Reviews the history of arc lighting. 2100 w. Engs' Year Bk, Univ of Minn—1901. No. 40933 C.

Combined Plant.

A Combined Electric Lighting and Steam Heating Plant. An illustrated description of a plant in Springfield, Ohio, where incandescent and arc lamps and steam radiators are all supplied from one power house. 4000 w. Am Elect'n—May, 1901. No. 40619.

Regulations.

The Board of Trade and Electric Lighting. Review of the expert evidence in an application for an alteration in one of the Board of Trade (England) regulations, providing that "no change should be made in the pressure of the supply to any premises . . . except with the consent of the consumer." 1600 w. Nature—April 18, 1901. No. 40627 A.

Street Lighting.

Thirteen Years' Experience with Municipal Street Lighting at Chicago, Ill. Edward B. Ellicott. An official report of results obtained and benefits derived from the service, with a comparison with the cost under private contract. 1700 w. Eng News—May 2, 1901. No. 40738.

Vapor Lamp.

Notes on the Cooper Hewitt Lamp. Peter Cooper Hewitt. A brief illustrated article giving curves showing the characteristics of brilliant vapor tube lamps. Also editorial comments. 2000 w. Elec Wld & Engr—April 27, 1901. No. 40604.

MEASUREMENT.

Direct Currents.

The Transformer for Measuring Large Direct Currents. Harris J. Ryan. Presents a method for large direct current calibrations that employs the transformer for comparing the values of large and small currents in terms of the ratio of transformation and the reading of the instrument used for measuring the small current. 2800 w. Trans Am Inst of Elec Engrs—April, 1901. No. 40984 D.

Electro-Dynamometer.

The Construction of an Electro-Dynamometer. S. M. Kintner. Illustrated description of instruments built by the students of the Western Univ. of Penn. 1300 w. Am Elect'n—May, 1901. No. 40624.

Frequency.

A Frequency Indicator, Power Factor Indicator, Wave Form Indicator, and the Thomson Load Meter. Brief illustrated descriptions of apparatus exhibited at the recent *conversazione* of the Am. Inst. of Elec. Engrs. 1000 w. Elec Rev, N. Y.—April 27, 1901. No. 40596.

Galvanometers.

An Inexpensive Mirror Galvanometer. A. P. Carman. Describes the details of construction, the cost, and the performance. Ill. 700 w. Technograph, No. 15—1900-1901. No. 41000 D.

Notes on the Use of the Differential Galvanometer. C. W. S. Crawley. Read before the Inst. of Elec. Engrs., England. Explains how this instrument may be effectively used for modern work. Ill. 2000 w. Elect'n, Lond—May 17, 1901. No. 41244 A.

Lost Work.

The Measurement of Lost Work in Dynamos (Messung der Arbeitsverluste in Dynamomaschinen). W. Penkert. With tables and diagrams showing the losses due to friction, eddy currents, and hysteresis. 2000 w. Elektrotech Zeitschr—May 9, 1901. No. 41173 B.

Meters.

Commercial Electric Meters. Guy Richardson Radley. Discusses the requirements, care, testing, etc. 3000 w. Technograph, No. 15, 1900-1901. No. 41-007 D.

Electric Meters for Various Rates (Elektricitätszähler für Mehrere Tarife). H. Aron. Describing a form of Aron meter for use when different rates are charged for current in different parts of the day. 1800 w. Elektotech Zeitschr—May 2, 1901. No. 41171 B.

Notes on Meter Testing. Arthur T. Smith. Hints on the testing of electric meters. 1200 w. Elec Rev, Lond—May 3, 1901. No. 40860 A.

Prony Brake.

Portable Prony Brake (Einstellbare Bandbremse). F. Hubert. A simple form of Prony brake, arranged with release to prevent the band from gripping the pulley, and adapted for ready application to electric motors. 1200 w. Elektrotech Zeitschr—April 18, 1901. No. 41162 B.

Recorder.

Voltage and Current Recorder. Frank W. Springer. Illustrated description of a device for recording the instantaneous values of current, or pressure, or both. 2100 w. Engs' Year Bk, Univ of Minn—1901. No. 40929 C.

Standardization.

Standardization of Electrical Apparatus. H. F. Parshall. From *Traction and Transmission*, London. Suggests the

standardization of the conditions of output, such as rise of temperature, regulation, efficiency, etc., and outlines the method. 3300 w. W Electn—April 27, 1901. No. 40608.

Testing.

The Testing of Iron at the Schuckert Works (Fabrikations massige Eisen prüfungen bei der Elektrizitäts-A-G. vormals Schuckert & Co., Nürnberg). J. A. Mollinger. A description of the methods employed for investigating the magnetic properties of iron for electrical constructions. 2000 w. Electrotech Zeitschr—May 2, 1901. No. 41170 B.

POWER APPLICATIONS.

Coke Works.

Electrical Plant at an Austrian Coke Factory. A Hartmann, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Illustrated description of the coking plant at the Orlau-Lazy Colliery. 1000 w. Col. Guard—May 10, 1901. No. 41040 A.

Cranes.

The Current Consumption of Electric Wharf-Cranes (Stromverbranch Elektrisch Hafenkrane). E. Krautschopp. Data and results of trials of the electrically driven wharf cranes of various builders in use at the port of Hamburg. 2500 w. Zeitschr d Ver Deutscher Ing—May 11, 1901. No. 41130 D.

Electric Drill.

An Electrically Driven Radial Drill. Illustrated description of a drill designed by Charles E. Willey. 600 w. Am Mach—May 2, 1901. No. 40705.

Factory Equipment.

Polyphase Equipment of Factories. W. Wyld. Read before the Birmingham Local Section of the Inst. of Elec. Engrs. Describes the polyphase alternating-current system and its advantages, and its application to factory driving. Ill. 6200 w. Elec Engr, Lond—May 10, 1901. No. 41016 A.

Requirements of Electricity in Manufacturing Work. William S. Aldrich. Considers briefly some essential features of electric power transmission in manufacturing work. 6300 w. Trans Am Soc of Mech Engrs, No. 898—May, 1901. No. 41086 C.

The New Mill and Power Plant of the Plymouth Cordage Company. Illustrated description of a plant for preparing and spinning binder twine at Plymouth, Mass., special attention being paid to the engine plant and power transmission. 1700 w. Eng Rec—May 11, 1901. Serial. 1st part. No. 40867.

Magnetic Tools.

See Mechanical Engineering, Shop and Foundry.

Mining Plant.

Practical Application of Polyphase Alternate-Circuit Machinery in Coal Mines. Illustrates and describes work carried out successfully at the Park Colliery, Garswood, and Sandwell Park Colliery, near Birmingham. 1600 w. Col Guard—April 19, 1901. No. 40640 A.

Electricity in Mountain Mines. F. W. Brady. Particulars and details of a few plants illustrating the general conditions and difficulties encountered in making different kinds of installations. 4800 w. Trans Am Inst of Elec Engs—April, 1901. No. 40985 D.

The Frongoch Zinc and Lead Mine, Wales. A short illustrated description of the electric plant and the appliances connected with the working of this mine. 1200 w. Eng & Min Jour—May 18, 1901. No. 41024.

Motors.

Dynamo and Motor Troubles and Their Remedies. W. L. Woodmansee. A statement of cases from the experience of the writer. 1500 w. Engr, U. S. A.—May 15, 1901. No. 40941.

The Relative Performance and Efficiency of Direct Current and Induction Motors. W. Elwell Goldsborough. Abstract of a lecture delivered before the Cleveland Electric Club. A comparison of the characteristics and discussion of the performance. 4000 w. Engr, U. S. A.—May 15, 1901. No. 40940.

Typewriter.

An Electric Typewriter. B. C. Washington, Jr. Illustrated description of an application of electricity to the operating of a typewriter, with explanation of the operation. 1100 w. Elec Wld & Engr—May 11, 1901. No. 40887.

Votometer.

The Bardwell Votometer. A. Francis Bardwell and James Hamilton. Explains the Australian and votometer systems of voting, and gives an illustrated description of the machine. 6000 w. Trans Am Soc of Mech Engrs, No. 901—May, 1901. No. 41089 C.

TRANSMISSION.

Australia.

Transmission of Electrical Energy From Brown Coal. Henry C. Jenkins. Considers the case of transmission of the power from Morwell to Melbourne, Australia. 1600 w. N. Z. Mines Rec—March 16, 1901. Serial. 1st part. No. 40796 B.

Grounding.

The Protective Value of Ground Connections (Der Schutzwerth der Erdung). F. Uppenborn. An examination of the conditions under which the grounding of

poles for high-pressure currents may prove of value as protection in case of accidents. 4500 w. Elektrotech Zeitschr—April 25, 1901. No. 41169 B.

High Tension.

Some Experiences with High Tension. A. C. Pratt. Observations on troubles and peculiarities incident to this class of work. 2000 w. Engs' Year Bk, Univ of Minn.—1901. No. 40930 C.

The Transmission of Current at High Potential in New York City. Calvin W. Rice. Read before the Nat. Elec. Light Assn. Shows in outline the advances which have made possible the generation of current in one large station, its transmission to sub-stations, and local distribution from each such center, describing the system in New York. 2000 w. Elec Rev, N. Y.—May 25, 1901. No. 41263.

Poles.

Conductor Poles of Iron and Wood (Leitungsmasten aus Eisen und Holz). J. Herzog and C. Feldmann. Illustrating several forms of combination poles constructed with base of structural iron and mast of wood. 2000 w. Zeitschr d Ver Deutscher Ing—May 11, 1901. No. 41132 D.

Power Transmission.

Electrical Transmission of Power From Mines. F. C. Caldwell. Read before the Ohio Inst. of Min. Engrs. The methods and principles which govern it and limit the profitable distance to which it may be applied. 2000 w. Mines & Min—May, 1901. No. 40690 C.

Regulation.

A Simple Diagram Showing the Regulation of a Transmission System for Any Load and Any Power Factor. F. G. Baum. A graphical study of certain problems, with computations and editorial notes. 2500 w. Elec Wld & Engr—May 11, 1901. No. 41072.

MISCELLANY.

Constitution.

Proposed Constitution of the American Institute of Electrical Engineers. Copy of proposed Constitution to be brought up for consideration at the annual meeting, May 21, 1901. 5500 w. Trans Am Inst of Elec Engr—April, 1901. No. 40988 D.

Exposition.

Electricity at the Pan-American Exposition, Buffalo, N. Y. An illustrated review of the plans executed and under way at Buffalo. 7000 w. Elec Wld & Engr—May 4, 1901. No. 40791.

Japan.

Japanese Electrical Work. R. G. Mayse. An account of points observed during a recent visit. Ill. 1500 w. W Elect'n—April 27, 1901. No. 40607.

Sandwich Islands.

Electricity in the Sandwich Islands. F. E. Grain. An account of recent progress, and present conditions. 2200 w. Elec Wld & Engr—May 4, 1901. No. 40790.

GAS ENGINEERING

Acetylene.

Acetylene Lighting Plants for Villages. Information furnished by Russell C. Miller, as to the selection of apparatus and the cost of producing gas. 1600 w. Met Work—May 4, 1901. No. 40832.

Address.

President's Address Before the Institution of Gas Engineers. W. R. Herring. The address deals with topics which the writer considers have an important bearing on future prosperity of the industry. 7000 w. Gas Wld—May 4, 1901. No. 40915 A.

Analysis.

The Analysis of Furnace Gases. A. W. Watson. Illustrates and describes the use of Hempel's apparatus in the analysis of chimney gases. 1700 w. B C Min Rec—May, 1901. No. 40875 B.

Blast Furnace Gases.

See Mining and Metallurgy, Iron.

Burners.

Observations on Gases Burned in Slit and Welsbach Burners. Dr. H. Bunte. Abstract. Experimental results are given and discussed. 1500 w. Gas Wld—May 11, 1901. No. 41015 A.

Distribution.

Gas Distribution as Viewed by an Electrical Man. Hubert S. Wynkoop. A discussion of pressure regulation, with diagrams. 1800 w. Am Gas Lgt Jour—May 6, 1901. No. 40781.

Electrolysis.

Electrolysis of Water and Gas Pipes. W. W. Brigden. Read before the Mich. Engng. Soc. Relates experience in Battle Creek, Mich., and in other places, and discusses the cure. The advantage of the double trolley is shown, and means of increasing the life of water and gas pipes discussed. 4200 w. Munic Engng—May, 1901. No. 40685 C.

The Electrolysis of Gas and Water Pipes. M. Claude. Some new ideas as to the electrolytic mode of action of the return currents of transmission installations. Ill. 4300 w. Engng—May 3, 1901. Serial. 1st part. No. 40850 A.

Gas Power.

Electric Light and Power Station at Halle (Elektrische Kraft und Licht Centrale der Werschen-Weissenfelser Braunkohlen Aktien Gesellschaft in Halle a. S.). O. Gähring. Showing the advantages of using the gas produced in the dry distillation of lignite as fuel for internal combustion motors. 2500 w. Glückauf—May 11, 1901. No. 41154 B.

Gas Practice.

Some Differences Between British and Continental Gas Engineering. C. E. Brackenbury. Read before the Inst. of Gas Engrs. The comparison is more favorable in most respects to the Continental practice. Discussion. 11000 w. Gas Wld—May 4, 1901. No. 40919 A.

Glasgow Exhibition.

Gas at the Glasgow Exhibition. A brief illustrated account of the exhibits in this field, still incomplete. 3300 w. Gas Wld—April 27, 1901. No. 40803 A.

The Glasgow Exhibition. An account of the lights, the exhibition of domestic and other gas appliances, etc., with editorial on the excellence of the high-pressure gas lighting. 6800 w. Jour Gas Lgt—April 30, 1901. No. 40864 A.

Incandescence.

A New Method for Illuminating with Incandescent Gas Mantles. Frederic Egner. An illustrated description of the Selas Light, with remarks on the recent improvements in gas-lighting appliances. 1700 w. Am Gas Lgt Jour—May 13, 1901. No. 40883.

Liquor.

Analysis of Leeds Gas Liquor. Arthur W. Cooke, in the *Journal of the Society of Chemical Industry*. Explains methods of analysis. 1800 w. Gas Wld—April 20, 1901. No. 40632 A.

Meters.

The Proportional Station Meter. George W. Barnes. Read before the Ohio Gas Lgt. Assn. Describes the operation of the proportional meter, and discusses its adaptability to the duties of a station meter. General discussion. 3600 w. Pro Age—May 1, 1901. No. 40699.

Natural Gas.

The Indiana Natural Gas Field. A. S. Moon. Reviews the conditions and troubles at the beginning of the natural gas industry and gives an illustrated description of two recent pumping stations. 3200 w. Power—May, 1901. No. 40672.

Purification.

Further Notes on Purification of Gas. S. Carpenter. An article prepared for students and young gas managers. On the testing for ammonia and other impurities. 1900 w. Jour Gas Lgt—April 23, 1901. Serial. 1st part. No. 40792 A.

Purification, and Method of Working Purifiers. B. W. Smith. Read before the Inst. of Gas Engrs. The paper is addressed to managers of small works, and deals with points of importance in the work that have come within the writer's large experience. Discussion. 1200 w. Gas Wld—May 4, 1901. No. 40918 A.

The Quantitative Estimation of Hydrogen Sulphide in Illuminating Gas. C. C. Tutwiler. Illustrated description of apparatus devised for the rapid analysis of gases. Its action depends upon the reaction between hydrogen sulphide and iodine. 1500 w. Am Gas Lgt Jour—April 29, 1901. No. 40605.

Supply.

Modern Gas Practice. Abstract report of the discussion of Mr. H. E. Jones' paper, read at the recent meeting of the Inst. of Civ. Engrs. 5300 w. Jour Gas Lgt—April 30, 1901. No. 40863 A.

Modern Practice in the Manufacture and Distribution of Gas. H. E. Jones. Abstract of a paper read before the Brit. Inst. of Civ. Engs. Briefly considers the cost, enrichments, purification, gasholders, and important advances. 2200 w. Gas Wld—April 20, 1901. No. 40630 A.

Tar.

Noxious Vapors From Tar Distillation. Extract from a report by John Craven and W. H. Coleman. Describes experimental work with the view of effecting more complete purification and doing away with inefficient methods. 2400 w. Gas Wld—April 20, 1901. No. 40631 A.

Water Gas.

Notes on Water Gas Manufacture. Thomas Holgate. Read before the Inst. of Gas Engrs. The paper deals with the Dellwik system, and the Strache system, and gives a large amount of information obtained by experiment and analysis. Discussion follows. Ill. 13000 w. Gas Wld—May 4, 1901—No. 40917 A.

Some Notes on the Conditions Which Prevail Within a Carburetted Water Gas Plant. W. J. Atkinson Butterfield. Read before the Inst. of Gas Engrs. Gives suggestions for improving the present results of the working of their plants. Discussion. 6400 w. Gas Wld—May 4, 1901. No. 40920 A.

Water Gas and Other Combustible Gases. Joh. Körting. Abstract translation of a communication to the Assn. of German Engrs. 2300 w. Jour Gas Lgt—April 30, 1901. Serial. 1st part. No. 40865 A.

MARINE AND NAVAL ENGINEERING

Barges.

Screw Barges. Illustrates and describes an interesting arrangement devised by H. Barcroft, of Newry, England, and adopted on some of the waterways of the United Kingdom. 1000 w. Sci Am Sup—May 4, 1901. No. 40745.

Bulkheads.

Electrically Controlled Bulkhead Doors. George E. Walsh. Information concerning the successful working of the apparatus on the U. S. cruiser "Atlanta," and the importance of the system. 1000 w. Am Elect'n—May, 1901. No. 40621.

"Celtic."

Launch of the New White Star Steamship "Celtic." Fine illustrations, with brief description. 350 w. Marine Engng—May, 1901. No. 40760 C.

Chain Towing.

The Steamers of the Bavarian Chain Towing Company (Die Kettendampfer der Kgl. Bayerischen Kettenschleppschiffahrt). With details of the engines and chain drum of these powerful towboats. 3000 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 27, 1901. No. 41126 D.

Cruisers.

New French Armored Cruisers "Leon Gambetta," "Jules Ferry," and "Victor Hugo." Particulars of these vessels as compared with the Drake class are given; the first installment dealing with the first named vessel. Ill. 1300 w. Engr, Lond—May 17, 1901. Serial. 1st part. No. 41251 A.

Swedish Cruisers with Superposed Turrets. Illustrated description of a vessel embodying novel features in gun placing. 800 w. Engr, Lond—April 19. 1901. No. 40652 A.

Cutter.

Steam Cutter Constructed by the Firm Sachsenberg Bros., Rosslau on the Elbe. Reprinted from *Schiffbau.* Illustrated description. 1000 w. Marine Engng—May, 1901. No. 40761 C.

Destroyers.

United States Torpedo Boat Destroyers "Lawrence" and "MacDonough." Plans and description of these boats now under construction. 1600 w. Marine Engng—May, 1901. No. 40766 C.

Distilling Plant.

Fresh Water Distilling Plant on the U. S. Store Ship "Iris." Illustrated description of this vessel of the U. S. Navy, and the arrangement for distilling. 1500 w. Marine Engng—May, 1901. No. 40765 C.

Economy.

The Progress of Economy in Marine Engineering. W. M. McFarland. A review of marine engineering, noting the lines along which progress has been made. 6400 w. Sib Jour of Engng—May, 1901. No. 41277 C.

Germany.

Germany's Progress as a Shipbuilding Nation. Edouard Lockroy. An account of the rapid development and the causes. 4000 w. Naut Gaz—May 9, 1901. No. 40877.

Japan's Navy.

Japan's Magnificent Navy. Dr. William Elliott Griffis, in Boston *Transcript.* An interesting outline of the growth of one of the largest and most powerful among the world's nations. 2000 w. Naut Gaz—May 2, 1901. No. 40840.

The Navy of Japan. Samuel E. Moffett. An illustrated account of the growth and present condition of the navy, which is unquestionably the first naval power in the far East. 2500 w. Rev of Revs—May, 1901. No. 40656 C.

Launching.

Not an Ordinary Launching. Illustrated description of the launching of the "Denver," the largest vessel ever built at the Wilmington works, Delaware. 1000 w. Marine Rev—May 2, 1901. No. 40837.

Liners.

Haverford and Merion. A description of two liners about to be launched in Scotland. Ill. 1500 w. Marine Rev—May 2, 1901. No. 40836.

Marine Engines.

The Marine Steam Engine. William Frederick Durand. Hints relating to the overhauling, adjustment and repair of marine machinery. 4300 w. Marine Engng—May, 1901. No. 40768 C.

The S. S. Port Royal and Port Antonio. Illustrated description of triple expansion engines for two new steamers built for the development of British trade with the West Indies. 1600 w. Engr, Lond—May 3, 1901. No. 40858 A.

Naval Scouts.

Naval Scouting and Despatch Vessels. S. Eardlay-Wilmot. Remarks called out by the paper on "A Design for a Fast Scout," by Vice-Admiral Fitzgerald, and its discussion, and not favorable to special vessels. 1400 w. Engr, Lond—April 26, 1901. No. 40808 A.

River Steamers.

River Steamer, General Pando. Illustrated description of a large stern-wheel steamer for service on the Amazon and its tributaries. 800 w. Engr, Lond—May 3, 1901. No. 40856 A.

Russia's Navy.

Russia's Readiness for War. Charles Johnston. A statement of the relations between Russia, China and Japan, with a comparison of the fleets of Russia and Japan, and also the armies. Ill. 3700 w. Rev of Revs—May, 1901. No. 40655 C.

Schooner.

Fishing Schooner "Rob Roy," Sailing Out of Gloucester, Mass. Illustrations, with description of one of the finest fishing vessels afloat. 800 w. Marine Engng—May, 1901. No. 40762 C.

Shipbuilding.

The Mechanical Equipment of the Shipyard. Prof. J. H. Biles. The second section of Prof. Biles' paper is devoted mainly to a discussion of the tools for working and securing the plating of a ship. 3000 w. Engineering Magazine—June, 1901. No. 41194 B.

Side-Wheel.

Passing of the Oscillating Engine—Sale of the S. S. "Ireland." Illustrated description of this Irish mail steamer, with a record of her dimensions and performances. 1200 w. Marine Engng—May, 1901. No. 40764 C.

Steamboat.

Handsome Excursion Steamboat. Illustrated description of a new 285-ft. vessel for the Detroit and Toledo route. 1100 w. Naut Gaz—May 2, 1901. No. 40838.

Submarine.

Submarine Boat for Polar Exploration. An account of a project to reach the pole in this way; the idea of Mr. Aushutz-Kampfe. 900 w. Naut Gaz—May 23, 1901. No. 41221.

U. S. Navy.

Ten Years' Naval Construction. J. H. Biles. Address before a recent meeting of the Inst. of Naval Architects, in London. Condensed. Reviews the progress of the navy in the United States, giving a comparison of types. 4800 w. Marine Rev—May 9, 1901. No. 40884.

Weights.

Weights of Ships. Theodore Lucas. On systems of weight classifications and calculations. 2500 w. Naut Gaz—May 2, 1901. No. 40839.

Yachts.

Construction of the Yacht "Constitution." Illustrated description of the design and construction. 2800 w. Sci Am—May 11, 1901. No. 40898.

The "Constitution." From the *N. Y. Sun*. A description of the new cup-defender built from the design of N. G. Herreshoff. 2800 w. Naut Gaz—May 9, 1901. No. 40878.

The Launch of "Shamrock II." Illustrated description of the boat with comments. 1400 w. Sci Am—May 11, 1901. No. 40897.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Electromobiles.

Electromobiles and Their Application to Public Transport (Ueber Elektromobilen und deren Verwendung als Oeffent-liches Werkehrsmittel). K. Simons. An examination into the elements of operative costs under the conditions existing in German cities. 4500 w. Elektrotech Zeitschr—April 18, 1901. No. 41165 B.

Exhibition.

Motor Car Exhibition at Islington. Remarks on the notable features, with illustrated descriptions of some of the exhibits. 1700 w. Engr, Lond—May 10, 1901. No. 41035 A.

Fire Engine.

Motor Steam Fire Engine. An illustrated description of a fire engine in England, recently connected from a horse-drawn engine into a self-propeller. 700 w. Engr, Lond—May 6, 1901. No. 41039 A.

Gasoline Carriage.

The Hasbrouck Gasoline Carriage. Illustrated description of a motor carriage propelled by a twin cylinder 6 horse power motor. 900 w. Horseless Age—May 8, 1901. No. 40879.

Ignition.

Two European Magneto-Ignition Systems. Illustrated descriptions of the Simms-Bosch igniter, and the Bergmann igniter. 1600 w. Horseless Age—May 1, 1901. No. 40663.

Liquid Fuels.

Alcohol and Petroleum Essence in Automobilism (L'Alcool l'Essence de Pétrole et l'Automobilism). E. Dieudonné. An examination of the relative calorific power of the liquid fuels with regard to their use in the internal combustion motors of auto-

mobile vehicles. 2500 w. Revue Technique—April 25, 1901. No. 41115 D.

Lorry.

Self-Propelled Lorry for Military Purposes. Particulars of an important competition being promoted by the Secretary of State for War with the object of introducing heavy automobiles for military purposes. 800 w. Engr, Lond—May 17, 1901. No. 41255 A.

Motor Traction.

Heavy Motor Traction. Editorial discussion of the progress made, the power required, the wear on roads, etc. 1500 w. Engr, Lond—May 17, 1901. No. 41252 A.

Roads.

Automobiles and Their Relations to Roads. A paper explaining the investigations now in progress to determine the tractive effort necessary to drive self-propelling vehicles over different classes of roads. 2700 w. Eng Rec—May 11, 1901. No. 40870.

Stirling Carriage.

The Stirling 7-H. P. Motor Carriage. Illustrated description of a vehicle comparatively free from transmission mechanism and having a high-power motor. 1200 w. Auto Jour—May, 1901. No. 41-239 A.

Storage Batteries.

Storage Battery Porosity. Thomas J. Fay. A discussion of vehicle batteries, giving a report of tests made and the advantages of batteries of the electric chemical type. 1400 w. Elec Rev, N. Y.—May 18, 1901. No. 41060.

Tires.

Automobile Tires. Frederick \.. Barker. Abstract from a lecture delivered at the Automobile Club of America. A discussion of the qualities they should possess, the kinds best suited to heavy vehicles, etc. 900 w. Horseless Age—May 1, 1901. Serial. 1st part. No. 40662.

Traction Engines.

Traction Engines for Transportation of Ores. G. P. Grimsley. Illustrated description of engines in use in California. 700 w. Eng & Min Jour—May 25, 1901. No. 41228.

Transmission Gear.

A Study of Variable Speed Gear (Etude sur les Changements de Vitesse). H. Noalhat. A general discussion of the problem, with details of a solution by the use of speed cones and planetary gears. Two articles, 6000 w. Revue Technique—April 10, 25, 1901. No. 41112 each D.

The Transmission Gear of a Motor Carriage. Herbert Austin. Read before the Cycle Engrs. Inst., London. Gives a brief summary of what the writer considers the essential features of a perfect system, and examines the various leading systems, and sees how far they comply with the requirements set forth. Ill. 7800 w. Auto Jour—May, 1901. No. 41240 A.

Vehicle Station.

The New York Electric Vehicle Transportation Company's New Station. Illustrated description of the new quarters and the numerous details of the service. 2000 w. Elec Rev, N. Y.—May 4, 1901. No. 40770.

HYDRAULICS.

Elevators.

Low Pressure Hydraulic Elevators. William Baxter, Jr. Illustrated detailed description of a vertical cylinder elevator and its operation. 1700 w. Am Mach—May 2, 1901. Serial. 1st part. No. 40704.

Flow.

A Study in Hydraulics. George H. Funkell. A study of interesting problems of the flow of water in pipes. Also discussion. 15000 w. Jour Assn of Engng Socs—March, 1901. No. 40989 C.

Experiments at Detroit, Mich., on the Effect of Curvature Upon the Flow of Water in Pipes. Gardner S. Williams, Clarence W. Hubbell, George H. Fenkell. An illustrated account of extensive experimental investigations, the constructions, apparatus, etc., used. The investigations cover only curves of 90°. 4000 w. Pro Am Soc of Civ Engrs—May, 1901. No. 41267 E.

Hydraulic Forming.

High Pressure Hydraulic Forming and Stamping System (Hydraulisches Hochdruck-Press-und-Pragverfahren). A. Riedler. A description of the Huber system, using the direct pressure of the liquid upon the die and material. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—April 27, May 24, 1901. No. 41127 each D.

Hydraulic Power.

The Use of Hydraulic Power in the Manufacture of Iron and Steel. R. M. Daelen. Read at meeting of the Iron & Steel Inst. On the use of the intensifier and the advantages; the application of high-pressure water to forging presses and the advantages. Ill. 2200 w. Ir & Coal Trds Rev—May 10, 1901. No. 41049 A.

Turbines.

Turbine Building and Turbo-Electric Stations in Switzerland. Prof. F. Prasil. The second section of Prof. Prasil's review deals mainly with the great hydro-electric plants at Chèvres and at Rheinfelden. 3500 w. Engineering Magazine—June, 1901. No. 41197 B.

Hydraulic Turbines at the Exposition of 1900 (Les Turbines Hydrauliques à l'Exposition de 1900). G. Lavergné. A

general review of the wheels exhibited at Paris, with especial reference to regulating devices. Two articles, 3500 w. April 20, 27, 1901. No. 41101 each D.

MACHINE WORKS AND FOUNDRIES.

Allis Works.

The New Works of the Edward P. Allis Co., at Milwaukee, Wis. Illustrated description. 2000 w. Eng News—May 23, 1901. No. 41208.

Analysis.

Chemical Analysis as an Aid to Foundry Work. Robert Buchanan. Treats of experiences in regular daily work, showing what chemical analysis can do to help the iron founder. 2000 w. Engng—April 26, 1901. No. 40804 A.

A Study of Balls for Ball Bearings (Etude sur les Billes pour Roulements). A translation of the recent paper presented before the *Verein Deutscher Ingenieure*. 5000 w. Revue de Mécanique—April, 1901. No. 41141 E + F.

Some Experiments on Ball Step-Bearings. C. H. Benjamin. An account of experimental investigations made at the Case School of Applied Science, describing apparatus used. Ill. 1500 w. Trans Am Soc of Mech Engrs, No. 896—May, 1901. No. 41084.

Bicycle Tools.

Machine Tools for Bicycle Manufacture (Machines-Outils pour la Fabrication des Vélocipèdes). G. Richard. Especially devoted to machines for constructing the wheels; mostly of American make. 5000 w. Revue de Mécanique—April, 1901. No. 41140 E + F.

Blue-Printing.

Blue-Printing by Electric Light. H. G. Reist. An illustrated description of an arrangement for printing which gives satisfactory results. 1000 w. Trans Am Inst of Mech Engrs, No. 900—May, 1901. No. 41088.

Cast Iron.

Fluid Iron for Casting. Walter J. May. Suggestions for cupola management, material, and matters necessary to secure good castings. 1100 w. Prac Engr—April 26, 1901. No. 40794 A.

The Constitution of Cast-Iron, with Remarks on Current Opinions Concerning It. H. M. Howe. An attempt to select the most probable working hypothesis, in studying the relation between the chemical composition and physical properties of cast-iron, and some steps toward testing it. 7500 w. Trans Am Inst of Min Engs—April, 1901. No. 40819 D.

Centrifugal Machinery.

Centrifugals at the Glasgow Exhibition. Illustrated description of new features in connection with the exhibit. 2200 w. Engng—May 17, 1901. No. 41258 A.

Connecting Rods.

A New Connecting Rod End. C. W. Hunt. Brief illustrated description. 800 w. Trans Am Soc of Mech Engrs, No. 903—May, 1901. No. 41091.

Crank-Shafts.

Turning Torpedo-Boat Crank-Shafts. Illustrated description of method used. 900 w. Am Mach—May 23, 1901. No. 41223.

Cupolas.

Anthracite Coal as a Cupola Fuel. Edward Kirk. Reviews the history of its use, the manner of charging, the use mixed with coke, etc. 2400 w. Foundry—May, 1901. No. 40660.

Drafting.

Drafting-Room and Shop Systems. Frederick O. Ball. A description of systems, with illustrations. 4000 w. Trans Am Soc of Mech Engrs, No. 904—May, 1901. No. 41092 C.

Rules for a Drawing Office. A. W. Robinson. A copy of revised rules. 1500 w. Trans Am Soc of Mech Engrs, No. 897—May, 1901. No. 41085.

English Shop.

A Progressive English Machine Shop. Robert I. Clegg. Describes the interesting features of the works of Howard & Bullough, at Accrington, manufacturers of textile machinery. 1600 w. Ir Trd Rev—May 9, 1901. No. 40882.

Forgings.

Die Forging. Joseph Horner. The first of a series of articles written with the object of illustrating the methods of stamping engineers' forgings in dies, to the lessening, or exclusion of anvil work, and of hand finishing. 3300 w. Engng—May 3, 1901. Serial. 1st part. No. 40843 A.

Foundry.

A Modern Foundry. Illustrated description of a finely equipped structure at Milwaukee, Wis. 1700 w. Foundry—June, 1901. No. 41280.

Foundry Mixtures.

Notes on Foundry Practice. Edward B. Gilmour. Discusses each of the important elements other than the iron, and its effect. 1400 w. Jour Am Found Assn—May, 1901. No. 40910.

Some Hints on Foundry Mixtures. Frank L. Crobaugh. Suggestions relating to the analysis of iron, scrap, coke, etc. 1400 w. Ir Trd Rev—May 2, 1901. No. 40701.

Furnace.

A Hot Blast Furnace. L. O. Danse. Illustrates and describes a flue system used to heat an enameling furnace with

hot blast. 800 w. Am Mach—May 9, 1901. No. 40890.

Gears.

A Gear Curio. Illustrated description of a curiosity in gearing, showing the action of the teeth. 700 w. Am Mach—May 9, 1901. No. 40891.

Bevel-Gear Cutting Machines at Paris. Fred. J. Miller. Illustrated detailed descriptions of various machines for this class of work, showing the practice in different countries. 8800 w. Trans Am Soc of Mech Engrs, No. 893—May, 1901. No. 41081 D.

Gear Molding Machine. An illustrated description of a superior gear molding machine. Its most striking feature is the method of inverting the functions of its leading parts in order to adapt it to the making of either small or large gears. 1000 w. Am Mach—May 9, 1901. No. 40892.

Heavy Machinery.

Moving Heavy Machinery. Suggestions with illustrations. 1800 w. Power—May, 1901. No. 40675.

Ladle.

Electric Travelling Ladle of 20 Tons Capacity (Elektrisch Angetriebener Giesspannenwagen fur 20 t Pfanneninhalt). Illustrated description of heavy electric ladle car built by Seussenbreuner of Düsseldorf. 600 w. Stahl und Eisen—March 15, 1901. No. 41141 D.

Lathes.

The First Large Turret Lathe. Thomas Coulter. An illustrated account of the first large turret lathe built or used in the United States. 1600 w. Ir Age—May 23, 1901. No. 41051.

Turret Lathe Practice. Illustrates and describes a semi-automatic turret lathe and its work. 2200 w. Mach, N. Y.—May, 1901. No. 40677.

Locomotive Works.

Hyde Park Locomotive Works, Springburn, Glasgow. Illustrated detailed description of the largest locomotive manufactory in Europe, and its equipment, with history of the undertaking. 14600 w. Engr, Lond—May 17, 1901. Serial. 1st part. No. 41250 A.

Machine Design.

Discrepancies of Precept in Machine Designing. Leicester Allen. An exposition of the wide divergence and disagreement of authorities over fundamental data and principles. 2500 w. Engineering Magazine—June, 1901. No. 41191 B.

Machine Tools.

A Special Form of Boring and Facing Machine. Walter S. Russel. Brief illustrated description. 400 w. Trans Am Soc of Mech Engrs, No. 906—May, 1901. No. 41093.

Machine Tools for Plates and Angles. Illustrated description of punching, shearing and bending machines driven by electricity. 600 w. Engr, Lond—May 17, 1901. No. 41254 A.

Portable versus Stationary Machine Tools. John Riddell. Illustrated description of some portable machine tools, comparing their work with the stationary tools formerly used. 800 w. Trans Am Soc of Mech Engrs, No. 899—May, 1901. No. 41087.

Tools for Interchangeable Manufacturing. Joseph Vincent. The first of a series of articles illustrating and describing practical points about the design and construction of jigs, tools, and fixtures used for the duplication of machine parts, aiming to show how unnecessary expense and work may be avoided. 2000 w. Mach, N. Y.—May, 1901. Serial. 1st part. No. 40679.

Magnetic Tools.

Electro-Magnets for Iron-Working Establishments. William Baxter, Jr. On the lifting capacity of magnets and the conditions giving the best results. 3700 w. Mach, N. Y.—May, 1901. No. 40678.

Magnetic Planer Clutch. Illustrates and describes a device invented by John Riddell which has been under test for about a year and given high satisfaction. 1000 w. Am Mach—May 2, 1901. No. 40703.

Micrometer Calipers.

The Use of Micrometer Calipers for Regular Machine Shop Gages. John T. Slocomb. An illustrated article explaining the uses made of the micrometer caliper in the machine shop. 1600 w. Am Mach—May 2, 1901. No. 40708.

Molding.

Molding Pulleys with Green Sand Arm Cores. Richard Barnett. Describes the method. Ill. 1300 w. Foundry—May, 1901. No. 40661.

Niles Works.

A Modern German Machine-Tool Shop, the Deutsche Niles Werkzeugmaschinen-Fabrik. Illustrated detailed description of these works in Berlin. 2800 w. Am Mach—May 16, 1901. Serial. 1st part. No. 40938.

Planing Tools.

The Possibilities of the Planing Tool. W. A. Warman and R. B. Cochrane. An illustrated article on the satisfactory use that may be made of the planing tool in removing stock and machining a true surface. 800 w. Am Mach—May 2, 1901. No. 40709.

Roller Bearings.

Notes on Rolling Bearings. William W. Estes. Where roller bearings will effect

saving, and the things tending to increase their economy, with discussion of various designs, and record of practical experience with the anti-friction bearings. 6000 w. Jour Worcester Poly Inst—May, 1901. No. 41065 C.

Sand Blast.

Cleaning Metalwork with the Sand Blast. Describes two plants, one consisting of a hoisting engine run backward to serve as an air compressor and delivering air into a boiler acting as a receiver. 1400 w. Eng Rec—May 4, 1901. No. 40724.

Soldering.

Machine Shop Soldering. C. H. Wilcox. On uses made of solder, and methods. Ill. 1000 w. Am Mach—May 2, 1901. No. 40706.

Stamping Machines.

Armature Plate Machines. Illustrated description of modern machines intended for dealing with armature stampings for dynamos and motors. 700 w. Engng—April 19, 1901. No. 40644 A.

Valves.

Globe Valve for Injector Throttle. William Newton. Illustrated description, with suggestions for constructing. 600 w. Am Mfr—May 2, 1901. No. 40759.

Pulley Press Valve. Francis H. Stillman. Illustrates and describes a large press operating valve, believed to be one of the most elaborate ever used to operate the motions of a single hydraulic press. 1000 w. Trans Am Soc of Mech Engrs, No. 894—May, 1901. No. 41082.

Westinghouse Works.

The Works of the Westinghouse Electric and Manufacturing Company. An illustrated detailed description of these interesting works and their fine equipment. 1800 w. Elec Rev, N. Y.—May 11, 1901. Serial. 1st part. No. 40885.

MATERIALS OF CONSTRUCTION.

Leather.

The Leather Industry at the Exposition of 1900 (L'Industrie des Cuirs et Peaux à l'Exposition de 1900). H. de la Coux. With especial reference to the improved processes for rapid tanning exhibited, and the influence upon the product. Two articles. 3500 w. Génie Civil—May 4, 11, 1901. No. 41104 each D.

Teak.

Teak Industry of Siam. Information concerning the teak-lumber business, the most valuable lumber for shipbuilding. 2500 w. U. S. Cons Repts, No. 1041—May 20, 1901. No. 40968 D.

Testing.

Experiments on Bending Notched Bars (Etude Expérimentale sur le Pliage des Barrettes Entaillées). MM. Fremont & Osmond. A review of tests made with scored bars according to the system of M. Fremont. 10000 w. Bull Soc d'Encour—April, 1901. No. 41123 G.

POWER AND TRANSMISSION.

Belting.

Rules Governing the Width of Leather Belting. J. J. Flather. A discussion of the considerations which determine the size of belts, with information relating to strength, care, cost, etc. 3500 w. Engs' Year Bk, Univ of Minn.—1901. No. 40936 C.

Compressed Air.

Compressed Air. J. J. Swann. A lecture before the Brooklyn Engs' Club. Briefly reviews the history of compressed air, its production, transmission and use. 5000 w. Compressed Air—May, 1901. No. 40927.

Diagram for Calculating Compressed Air Pressure. Presents and explains a graphic table intended to facilitate calculations in power transmission. 200 w. Min & Sci Pr—April 27, 1901. No. 40669.

Test of an Hydraulic Air Compressor. William O. Webber. A record of results obtained in some tests at the plant of the Dominion Cotton Mills Company, Limited, at Magog, P. Q., Canada. Ill. 1300 w. Trans Am Soc of Mech Engrs, No. 889—May, 1901. No. 41077.

The D'Auria Air-Compressor. Henry G. Morris. Illustrates and describes a new form of air-compressor, and stating its advantages. 1400 w. Trans Am Inst of Min Engs—April, 1901. No. 40826 D.

Friction.

Friction. Discusses the important laws to be remembered by those having charge of machinery. 1800 w. Engr, U. S. A.—May 1, 1901. No. 40667.

Heating Plant.

A Fan and Furnace School-Heating System. Illustrated description of a plant in an Oshkosh schoolhouse, where air is forced by a fan into a chamber containing hot-air furnaces from which it passes through flues to the rooms. 900 w. Eng Rec—May 18, 1901. No. 40966.

Gas Power.

See Gas Engineering.

Power Plants.

The Power Plants of the Pan-American Exposition. A description of the steam and gas engines and electric power apparatus. 2800 w. Eng Rec—May 25, 1901. No. 41216.

Prony Brake.

See Electrical Engineering, Measurement.

Rolling Disc.

The Mechanics of a Rolling Disc. G.

A. Goodenough. A statement of the problem and its solution. Ill. 2300 w. Technograph, No. 15—1900-1901. No. 41002 D.

Rope Transmission.

A Rope Transmission Plant at Buffalo, N. Y. Illustrated description of the plant at the Spencer Kellogg Linseed Oil Works. 2500 w. Power—May, 1901. No. 40670.

SPECIAL MOTORS.

Diesel Motor.

Some Recent Tests of the Diesel Oil Engine. Bryan Donkin. (Summarized from Prof. Eugene Meyer's report). On experiments made in Sept., 1900, on two vertical single-acting Diesel engines, to test them for efficiency and steadiness. 1500 w. Engr, Lond—April 26, 1901. No. 40809 A.

Gas Engine.

A 1,000 Horse-Power Gas Engine and Compressor. E. E. Eysenbach. Read before the Ohio Gas Lgt. Assn. Describes a gas-engine having four 25 x 48-in. engine cylinders, and two 16 x 24-in. gas compressing cylinders. The pump is rated at 12,000,000 cu. ft. of gas at 315 lbs. in 24 hours, the inlet pressure being 100 lbs. 1200 w. Eng Rec—May 4, 1901. No. 40725.

Efficiency Tests of a One-Hundred-and-Twenty-Five-Horse-Power Gas Engine. C. H. Robertson. Illustrated description of the plant tested and results of tests made in April and May, 1900. Table, cards, curves, and full information. 6800 w. Trans Am Soc of Mech Engrs, No. 907—May, 1901. No. 41095 D.

Lecture to Columbia Students on the Gas Engine. William P. Flint. Presents the advantages of gas engines, discusses the problem of governing, ignition, etc., and briefly reviews the history. 5500 w. Am Mfr—May 2, 1901. No. 40758.

Three Hundred Horse Power Tandem Gas Engine (Dreihundertpferdiger Tandem Gas Engine). V. Schönbach. Description of the Delamare-Debouteville engine at the Königshof iron works in Bohemia, using blast-furnace gas. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 30, 1901. No. 41156 B.

Ignition.

Liquid Interrupters. James T. Sibley. Gives illustrated description of the Caldwell and Wehnelt types, and reports their use with good results on a gas engine. 800 w. Horseless Age—May 22, 1901. No. 41222.

Pre-Ignitions and Miss-Fires in Oil Motors. Discusses the causes and effects. 3500 w. Prac Engr—April 26, 1901. No. 40793 A.

Speed-Variations.

Speed-Variations Occurring During the Cycles of the Otto Gas Engine and the Diesel Heat Motor. Abstract of the results of thesis work, edited by Prof. Sidney A. Reeve. 1800 w. Jour Worcester Poly Inst—May, 1901. No. 41066 C.

STEAM ENGINEERING.

Boilers.

Stirling Water-Tube Boiler at the Glasgow Exhibition. Illustrated description of two boilers in use at the Glasgow Exhibition for the generation of steam for driving the power plant, one of which is fitted with a Vickar's stoker, while in the other producer gas is used. Also report of trials, and illustrations of tube cleaners. 2800 w. Engng—May 17, 1901. No. 41259 A.

The Boiler and Boiler-Room. W. J. Ranton. On recent improvements in boilers and boiler construction, their care, etc. 2200 w. Power—May, 1901. No. 40674.

The Distribution of Heat in Boilers. Editorial, calling attention to points overlooked and facts seemingly misunderstood. 2200 w. Engr, Lond—May 10, 1901. No. 41036 A.

The Horse Power of Boilers. W. H. Wakeman. A criticism of ideas expressed in an article appearing in this same paper, claiming that there is no such thing as the horse power of a boiler, when considered independently of the engine. 1500 w. Elec, N. Y.—May 22, 1901. No. 41070.

The Thornycroft-Marshall Water-Tube Boiler. Illustrations, with a statement of the advantages claimed. 1500 w. Engr, Lond—May 3, 1901. No. 40857 A.

The Solignac and Grille Marine Boiler (Chaudière Marine de MM. Solignac et Grille). J. Prouteau. Describing this improved form of water-tube boiler, with forced circulation and especial ease of access. 2000 w. Revue Technique—March 25, 1901. No. 41108 D.

The Solignac and Grille System of Instantaneous Boiler-Cleaning (Système de Nettoyage Instantané et sans Arrèt de leur Chaudière à Vapeur). MM. Solignac and Grille. Describing the method by which a powerful circulation is used to clean the tubes of the inventors' water-tube boiler. 2500 w. Soc Ing Civ de France—March, 1901. No. 41182 G.

The Solignac Water-Tube Boiler. Information concerning the boilers of Solignac, Grille and Cie, with estimated comparisons between what they can do and some other types of boilers. Illustrates the construction. 2600 w. Engr, Lond—May 3, 1901. Serial. 1st part. No. 40854 A.

Water-Tube Boilers. Abstract of a paper by R. J. Worth, read at Middlesbrough meeting of the Cleveland Inst. of Engrs., condemning the Belleville boiler, and discussing other types. General discussion.

4000 w. Ir & Coal Trds Rev—May 3, 1901. No. 40851 A.

Water-Tube Boilers. Edwin Griffith. Read before the North-East-Coast Inst. of Engrs. & Shipbuilders. The object of the paper is to consider the present position of water-tube boilers from the point of view of the marine engineer. 5500 w. Engr, Lond—May 17, 1901. No. 41257 A.

Boiler Tubes.

Description of the Manufacture of Seamless Steel Boiler Tubes. C. A. M'Allister. Brief description, with requirements for all seamless cold drawn steam tubes furnished to the U. S. government. 3000 w. Marine Engng—May, 1901. No. 40767 C.

Chimneys.

A Concrete Chimney. Ralph C. Davison. Illustrated description of a chimney built at Elizabethport, N. J., for the Seiger Mfr. Co. It is of the Ransom cold-twisted iron construction, 125 ft. high, with a 9-foot flue. 1000 w. Sci Am—May 18, 1901. No. 40923.

Construction of a Steel Chimney. A. H. Neureuther. An illustrated description of the construction of a stack erected in Peru, Ill. 1800 w. Technograph, No. 15—1900-1901. No. 40999 D.

Stability of a Tall Chimney. Carl Hays. An examination of the stability of a chimney erected at Urbana, Ill., and its maximum pressure on the masonry and on the soil. 1000 w. Technograph, No. 15—1900-1901. No. 41008 D.

Clearance.

A Test of Cylinder Clearance. An account of an exhaustive test to determine the effect of clearance upon the question of steam economy. 4500 w. Power—May, 1901. No. 40673.

Condensation.

Disposing of the Water of Condensation. C. W. Obert. Illustrates and describes various methods of draining of the water. 1400 w. Am Elect'n—May, 1901. No. 40625.

Cooling Tower.

The Zschocke Cooling Tower for Condensing Water. An illustrated description of a tower erected at the station of the Birkenhead Corporation Electric Tramways, which works very successfully. 800 w. Engng—May 10, 1901. No. 41042 A.

Economy.

Economy in Steam Production. C. W. Obert. Discusses the important factors in the cost of steam production. 2300 w. Am Elect'n—May, 1901. No. 40623.

Possible Additional Economics at the Steam End of the Mill. Abstract of a paper by O. C. Woolson, before the New England Cotton Mfrs. Assn., on the economy attainable by careful attention to methods of handling coal and ashes. 1800 w. Eng Rec—May 4, 1901. No. 40723.

Efficiency.

Actual Efficiency in Steam Generation. A. Bement. A study of the conditions involved in the attainment of high efficiency, including the difficult personal element. 3000 w. Engineering Magazine—June, 1901. No. 41195 B.

Engine Tests.

Preliminary Report of the Committee Appointed to Codify and Standardize the Methods of Making Engine Tests. 19500 w. Trans Am Soc of Mech Engrs, No. 891—May, 1901. No. 41079 E.

Test of a 65 H.-P. Bates Corliss Engine. Charles A. Happin. Tests made at the plant of the Twin City Water Works, Urbana, Ill. 1300 w. Technograph, No. 15—1900-1901. No. 41001 D.

Test of a Three Cylinder Steam Engine (Untersuchung einer Dreicylinder Dampfmaschine). H. Lorenz. Details of test of 600 h. p. triple-expansion engine, with and without steam-jackets, at the Portland cement works, at Misburg, near Hannover. 2000 w. Zeitschr d Ver Deutscher Ing—May 11, 1901. No. 41129 D.

Tests of the Hardill Compound Engine. W. J. Childs and O. W. Bodler. Illustrated description of the special features of the engine, with account of tests. 1100 w. Sib Jour of Engng—May, 1901. No. 41278 C.

Flywheels.

Determination of Fly Wheels to Keep the Angular Variation of an Engine Within a Fixed Limit. J. J. Astrom. Attempt to indicate a method by which the regulating capacity of a fly-wheel upon the motion of an engine may be positively determined. 5000 w. Trans Am Soc of Mech Engrs, No. 892—May, 1901. No. 41080 C.

Heating.

See Electrical Engineering, Generating Stations.

Marine Engines.

See Marine and Naval Engineering.

Multiple Expansion.

The Proportions of Cylinders for Multiple Expansion Engines. Alfred Hanssen. A mathematical explanation of the writer's method of finding the actual area of the cylinders. 2200 w. Engng—May 3, 1901. No. 40849 A.

Portable Engines.

Portable Steam Engines (Lokomobilen). H. Dübbel. A discussion of the agricultural type of portable engines, especially with a view to fuel economy. 2000 w. Zeitschr d Ver Deutscher Ing—May 11, 1901. No. 41133 D.

Power Plant.

Starting of a New Power Plant. I. H. Sherwood. Discusses the methods to be observed in putting in operation an installation of steam and electric machinery. 2300 w. Engr, U. S. A.—May 1, 1901. No. 40666.

Recording Machine.

An Automatic Recording Machine. E. C. Oliver. Illustrated description of a machine for recording on a continuous strip of paper the momentary changes of conditions throughout a test of an engine. 1500 w. Technograph, No. 15—1900-1901. No. 41005 D.

Smoke.

Smoke and Grit From Electric and Factory Chimneys. Discusses the subject of recording and diminishing smoke, etc. 1800 w. Elec Rev, Lond—May 17, 1901. Serial. 1st part. No. 41246 A.

Speed Variation.

Theoretical Estimation of the Internal Speed Variation of a 3500 Horse-Power Vertical Cross-Compound Engine. W. L. Abbott. Investigation to determine the amount of variation which would occur in the relative positions of the armatures of alternating current dynamos, and to see if it would be great enough to put the dynamos out of step, or if the amount of cross current would be objectionable. 2700 w. Technograph, No. 15—1900-1901. No. 40993 D.

Steam Engines.

A French Corliss-Type Steam Engine. Illustrated detailed description of a horizontal triple expansion engine driving 1,000 kw. alternator. 1100 w. Am Elect'n—May, 1901. No. 40622.

Horizontal Triple-Expansion Engine (Liegende Dreifachexpansions-Dampfmaschine). M. Schmidt. An illustrated description of an engine of 2,000 to 2,500 h. p., with rope drive. An illustration is given of the special car for the transport of the 24 ft. fly wheel. 1200 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 20, 1901. No. 41124 D.

Modern Practice in Steam Engine Construction. Illustrates and describes recent improvements, with general remarks. The illustrations are mostly of horizontal engines, but only because this type offers a wider range of examples and practice. 5700 w. Am Elect'n—June, 1901. No. 41210.

6000-H. P. Westinghouse Engines for the New York Gas and Electric Light, Heat and Power Company. Illustrated description. 2000 w. Eng News—May 23, 1901. No. 41204.

Steam Heating.

The Development of the Steam Hot Blast System of Heating and Ventilation. B. S. Harrison. A nontechnical description of this system and its development. 1800 w. Engs' Year Bk, Univ of Minn.—1901. No. 40932 C.

Superheating.

Boilers and Engines for Superheated Steam (Kessel und Dampfmaschinen für Ueberhitzten Dampf). H. Hunger. A discussion of the importance of using properly designed engines and boilers if the full benefits of superheating are to be obtained. 2500 w. Zeitschr d Ver Deutscher Ing—April 27, 1901. No. 41128 D.

New German Boilers and Engines for Superheated Steam. Abstract of a paper by Oscar Hunger, before the Soc. of German Engrs., describing the details of boilers and engines best adapted for superheated steam. 2700 w. Eng Rec—May 18, 1901. No. 40967.

Superheated Steam. Ernest H. Foster. Briefly reviews the history of superheating, discusses the increased efficiency and methods. 3700 w. Trans Am Soc of Mech Engrs, No. 909—May, 1901. No. 41097.

The Practical Application of Superheated Steam. George A. Hutchinson. Defines superheated vapor and applies the law to a concrete case, showing the advantage and the economy. Discusses the requirements of a superheater and gives illustrated descriptions of various designs. 7800 w. Trans Am Soc of Mech Engrs, No. 902—May, 1901. No. 41090 D.

Turbines.

The Steam Turbine. An explanation of the action with proof of statements. 1800 w. Power—May, 1901. Serial. 1st part. No. 40671.

Water Hammer.

The "Water Ram" in Blow-Off Pipes. On the importance of keeping the blow-off pipe free from deposits, and the danger of opening and closing valves suddenly; giving an account of an accident which occurred from the water-ram action in a blow-off pipe caused by closing the blow-cock too quickly. 2000 w. Locomotive—April, 1901. No. 41063.

MISCELLANY.

Address.

Presidential Address of William H. Maw, before the Institution of Mechanical Engineers. Abstracted. On the present position of the mechanical engineer. 5000 w. Engr, Lond—April 26, 1901. No. 40816 A.

Aeronautics.

Aerial Navigation (La Navigation Aérienne). E. Dieudonné. Giving an account of the experiments with the aeroplane of Kretz, recently made in the environs of Vienna. 2000 w. Revue Technique—March 25, 1901. No. 41110 D.

Hofman's Flying Machine. Brief illustrated description. 500 w. Sci Am—May 4, 1901. No. 40744.

Baling Cotton.

A Method of Preparing and Baling Cotton in Round Bales of Uniform Lap. John R. Fordyce. Illustrated description of machine and method, and related matter. 3800 w. Trans Am Soc of Mech Engrs, No. 908—May, 1901. No. 41096 C.

Education.

The Training Course for Engineers of the General Electric Company. Thomas Howe. An account of the system of training employed. Ill. 2000 w. Sib Jour of Engng—May, 1901. No. 41279 C.

Ericsson.

Personal Recollections of Captain John Ericsson. Egbert P. Watson. Interesting personal reminiscences heretofore unpublished; also engraving of oil portrait from life. 3000 w. Engineering Magazine—June, 1901. No. 41196 B.

Indexing.

A Method of Filing and Indexing Engineering Literature, Notes, Data, etc. George H. Marr. Describes the use of Dean's Document File. Ill. 2400 w. Trans Am Soc of Mech Engrs, No. 890—May, 1901. No. 41078.

Labor.

Lessons from the Experience of British Organized Labor. F. Brocklehurst. A review of the labor situation in England for the past fifty years, showing the futility of resisting improved machinery and methods. 2500 w. Engineering Magazine—June, 1901. No. 41192 B.

Machinists' Strike.

The Machinists' Strike. Reports from all sections of the country concerning the strike for ten hours' pay in return for nine hours' work. 15000 w. Ir Age—May 23, 1901. No. 41054.

Refrigeration.

Air Circulation in Cold Stores. Madison Cooper. Discusses the distinction between circulation and ventilation, how to promote circulation, and the methods that hinder. 4000 w. Ice & Refrig—May, 1901. Serial. 1st part. No. 40729 C.

A Porto Rico Ice Plant. William E. Groff. Illustrates and describes the plant of the San Juan Ice and Refrigerating Co., and the difficulty met in constructing it. 800 w. Ice & Refrig—May, 1901. No. 40730 C.

Cold Storage Plant in Belgium. Illustrated description of its construction and equipment. 3000 w. Ice & Refrig—May, 1901. No. 40728 C.

Process of Refrigeration. Arthur Pennell. Describes the process briefly. 1100 w. Ice & Refrig—May, 1901. No. 40731 C.

Slide Rule.

The Precision of the Slide Rule. Louis Derr. Gives some precision tests which show that more accurate results than usually credited can be obtained. 900 w. Tech Quar—March, 1901. No. 40975 E.

Ventilation.

Ventilation: Success and Failure of Methods at Present in Use. Christopher Childs. Discusses chiefly the various methods for the ventilation of schools. Also general discussion. 15800 w. Jour San Inst—April, 1901. No. 41273 F.

MINING AND METALLURGY

COAL AND COKE.

Alabama.

The Alabama Coal Fields. Henry McCalley. Their location and characteristics with an account of the early discoveries and development and the present output. Ill. 4000 w. Mines & Min—May, 1901. No. 40694 C.

Anthracite.

History of Anthracite Coal Production in Pennsylvania. A graphic illustration by a chart prepared by William W. Ruley. The article discusses the probable life of these coal fields. 600 w. Min & Met—May 1, 1901. No. 41014.

Chinese Coals.

The Composition of Chinese Coals. M. Monod, in *Moniteur Industriel.* Information concerning the coal-bearing strata, with analyses of samples collected during travels, showing that some of the coals can rival the best known fields. 1300 w. Col Guard—May 17, 1901. No. 41249 A.

Coke.

The Coke Industry in the United States. An advance summary of a report about to be issued by the Census Office, compiled by E. W. Parker. 2400 w. Ir Age—May 2, 1901. No. 40657.

The Electric Plant at the Orlau-Lazy Coke Works (Die Elektrische Anlage in der Cokesanstalt Orlau-Lazy). A. Hartman. An account of a modern coke plant with by-product, ovens and electric charging machinery in Silesia. 1200 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—May 4, 1901. No. 41159 B.

The Manufacture of Coke. Edward W. Parker. Abstracted from the special re-

port of the U. S. Census. Refers principally to the manufacture during 1899, and is limited to the product usually termed "oven cake." 3000 w. Pro Age—May 15, 1901. No. 40943.

Coke Works.

See Electrical Engineering, Power Applications.

Equipment.

Modern Colliery Surface Equipment. Illustrated description of economic coal-mining appliances, as shown in a plant erected in South Wales. 3300 w. Ir & Coal Trds Rev—April 26, 1901. No. 40818 A.

Germany.

The German Coal and Coke Syndicates and the Reaction in the Iron Industry. An explanation of the changed conditions of industry. 2400 w. Col Guard—April 26, 1901. No. 40807 A.

Internal Heat.

The Development of Heat in Coal Mines (Die Wärmeverhältnisse im Kohle Führenden Gebirge). H. Höfer. A discussion of the ratio of the development of temperature with depth, with especial reference to the striking of a seam of water of 90° F. at a depth of 1150 feet, near Teplitz, Bohemia. Serial, Part I. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 11, 1901. No. 41160 B.

Mexico.

Coal Mining in Mexico. An illustrated description of the development of a coal field in the state of Coahuila, as reported in *Modern Mexico*. 450 w. Col Guard—April 26, 1901. No. 40806 A.

Outcrops.

Coal-Outcrops. Continued discussion of Mr. Catlett's paper, presented at the Canadian meeting. 900 w. Trans Am Inst of Min Engs—April, 1901. No. 40824 D.

Peat.

Swedish Peat-Fuel Machinery. Illustrates and describes the two most important processes of peat manufacture in use. 5000 w. Engr, Lond—May 17, 1901. No. 41256 A.

The Peat Fuel Question in Sweden. Some facts concerning the utilizing of peat, because of the heavy prices of coal. 1500 w. Engr, Lond—May 3, 1901. No. 40855 A.

Pitch.

Across the Pitch versus Up the Pitch. O. E. S. Whiteside. Read at the meeting of the Canadian Min. Inst. Discusses when each method is to be preferred, the manner of operating, etc. 1100 w. Eng & Min Jour—May 18, 1901. No. 41020.

Poland.

The Coal and Iron Industries of Poland. Particulars regarding these industries for the year 1900. 3000 w. Col Guard—May 3, 1901. No. 40853 A.

South Wales.

Coal and Mines of South Wales. A Howells. Read before the Ohio Min. Inst. Considers why Welsh coal can withstand competition and yet command a higher price; also the difficulties met in mining it. 2700 w. Mines & Min—May, 1901. No. 40695 C.

Tennessee.

Brushy Mountain Coal Mines. A. W. Evans. An illustrated description of the coal, the methods of mining and the haulage plant. 2000 w. Mines & Min—May, 1901. No. 40691 C.

Trestle Work.

Steel Trestle and Storage Pockets for Coke Ovens. Illustrated description of works erected for the New England Gas and Coke Co. 900 w. Engr, Lond—April 26, 1901. No. 40813 A.

United Kingdom.

The New Coal Question. A full supplement, with editorial, and trade opinions concerning the justice and expediency of levying an export tax on coal. 35000 w. Ir & Coal Trds Rev—April 26, 1901. No. 40817 A.

Whitehaven Collieries.

Improvements at the William Pit, Whitehaven Collieries, Cumberland. These collieries are remarkable for the large area of under-sea workings, and the long haulage. An illustrated account of changes in methods of working, and the introduction of endless rope haulage. 1200 w. Ir & Coal Trds Rev—April 19, 1901. No. 40638 A.

COPPER.

Assaying.

See Electrical Engineering, Electro-Chemistry.

British Columbia.

The British Columbia Copper Company's Mines. E. Jacobs. Illustrations and description of some of the work done by this company. 1800 w. Eng & Min Jour—May 18, 1901. No. 41022.

Chile.

A Curious Copper Deposit in Chile. J. A. W. Murdoch. Illustrated description of a deposit in the Desert of Atacama, over 7,400 ft. above sea level. 900 w. Eng & Min Jour—May 11, 1901. No. 40894.

Deposits.

Types of Copper-Deposits in the Southern United States. J. H. Kemp. Discussion of the paper of W. H. Weed, presented at the Washington meeting. 1200 w. Trans Am Inst of Min Engs—April, 1901. No. 40828 D.

Extraction.

The Extraction Plant of the Arlington Copper Company. A. Von Zwaluwenberg. Briefly describes the method of treating the ore at Arlington, N. J. 600 w. Eng & Min Jour—May 25, 1901. No. 41225.

Germany.

Production and Consumption of Copper in Germany. Gives expert's estimates of the yield of various countries, the uses to which the product is applied in Germany, the price, etc. 700 w. U. S. Cons Repts, No. 1032—May 9, 1901. No. 40751 D.

New Caledonia.

Copper Lodes of New Caledonia. Ernest A. Weinberg. Read before the Australasian Inst. of Min. Engrs. An illustrated account of the deposits on this island of the Southern Pacific, and the mines worked. 1800 w. Aust Min Stand —March 28, 1901. Serial. 1st part. No. 40799 B.

Pneumatic Processes.

Pneumatic Processes for Leaching and Cyaniding. J. Ohly. A study of processes covered by patents, of importance in the extraction of copper and of gold because of the increased output, and the saving of time. 2300 w. Min & Sci Pr—April 27, 1901. No. 40668.

Production.

Copper Production. Editorial review of statistics of supplies for past year which show the influence of the copper combine. 1200 w. Engng—April 26, 1901. No. 40-805 A.

GOLD AND SILVER.

Abyssinia.

Gold Mining in Abyssinia. Information concerning the probability of these deposits being worked by modern methods. 1100 w. Aust Min Stand—March 21, 1901. No. 40797 B.

Africa.

The Gold-Fields of the West Coast of Africa. The article describes the conditions to be found, but gives little information concerning the deposits. 1700 w. Eng & Min Jour—May 18, 1901. No. 41027.

Alaska.

Gold Mining in Alaska. H. van F. Furman. An illustrated description of the southeastern part of the country, its formations and some of the mines. 3800 w. Mines & Min—May, 1901. No. 40689 C.

Australia.

Gold Mining and Milling in Western Australia. A. G. Charleton. Mr. Charleton's concluding paper deals with the milling and cyaniding practice at Kalgoorlie, with data as to output and cost. 5000 w. Engineering Magazine—June, 1901. No. 41193 B.

See Civil Engineering, Construction.

British Columbia.

Cadwallader Creek Mining Camp, Lillooet Mining District, British Columbia. William M. Brewer. The history, geology, development, etc., of this gold-mining camp. Ill. 2200 w. Eng & Min Jour—May 18, 1901. No. 41019.

Silver Lead. Memoranda, showing the urgent need of legislation in favor of this industry in British Columbia, presented by a deputation of mine owners to the Canadian Government. Ill. 4800 w. Can Min Rev—April 30, 1901. No. 40750 B.

The Auriferous Quartz Deposits of Southern British Columbia. J. D. Kendall. An account of these deposits, the earlier locations, some general features of the deposits, methods of promoters, etc. Ill. 7400 w. B C Min Rec—May, 1901. No. 40874 B.

Colorado.

New Life for Leadville. An account of present conditions, the great activity, new companies, gold values, etc. 2000 w. Min Inv—April 29, 1901. No. 40687.

The Cripple Creek and Leadville Mining Districts. Lecture delivered by C. J. Moore, illustrating the characteristic features of these camps. 5500 w. Min Inv —April 29, 1901. No. 40688.

Cyanide Mill.

The Dorcas Pneumatic Cyanide Mill. E. F. Gropells. Illustrated description of a custom mill constructed to treat ore from the Cripple Creek district of Colorado. Its capacity is 120 tons per day. 900 w. Min & Sci Pr—May 11, 1901. No. 40924.

Iron-Sands.

Notes on the Auriferous Iron-Sands of New Zealand. Alexander McKay. Information concerning these deposits in various districts and their workings. 8200 w. N Z Mines Rec—March 16, 1901. Serial. 1st part. No. 40795 B.

Nome.

The Placer Gold Fields of the Nome Region. Alfred H. Brooks. An illustrated account of the present condition and future possibilities of this region. 2700 w. Min & Met—May 1, 1901. No. 41009.

Placer Mining.

An Atlin Hydraulic Mine. Brief illustrated account of the mining conditions in this district of British Columbia. 800 w. Min & Sci Pr—May 11, 1901. No. 40925.

Pneumatic Process.

See Mining and Metallurgy, Copper.

Siberia.

The Gold Mining Industry of Siberia. H. L. Geissel. Describes the great gold-mining regions, and the machinery and

tools in general use. 2000 w. Min & Met —May 1, 1901. No. 41010.

Smelting.

Pyritic Smelting in the Black Hills. Franklin R. Carpenter. Discussion of this paper by H. Van F. Furman. 1000 w. Trans Am Inst of Min Engs—April, 1901. No. 40822 D.

Sumatra.

Gold Mining in Sumatra. George R. Wright. Information concerning the Redjang Lebong Gold Exploitation Company. 500 w. Eng & Min Jour—May 25, 1901. No. 41227.

Vancouver Island.

Auriferous Black Sands of Vancouver Island, B. C. W. M. Brewer. An account of the difficulty met in saving the gold, and the recent success; also discusses the source. 1500 w. Eng & Min Jour—May 18, 1901. No. 41023.

IRON AND STEEL.

Acid-Steel.

The Economical Significance of High Silicon in Pig-Iron for the Acid Steel Processes. Axel Sahlin. Read before the Iron and Steel Inst. A plea for low silicon iron. 2200 w. Ir & Coal Trds Rev—May 10, 1901. No. 41047 A.

Bertrand-Thiel.

The Bertrand-Thiel Process. John W. Cabot. Observations from a recent study of the process at the works where it originated, with conclusions. 2800 w. Ir Age —May 2, 1901. No. 40659.

Bessemer Works.

A Description of the Bessemer Shop and Heating Pits at the Barrow Hematite Steel Company's Works, Barrow-in-Furness. J. M. While. Read before the Iron and Steel Inst. 2500 w. Ir & Coal Trds Rev—May 10, 1901. No. 41046 A.

Blast-Furnace Gases.

Dust in Blast-Furnace Gases. Adolphe Greiner. Read before the Iron & Steel Inst. Information of use to those using this gas in gas-engines. Also discussion. 4300 w. Ir & Coal Trds Rev—May 10, 1901. No. 41045 A.

Progress in the Application of Blast Furnace Gases to Power Generation. (Weitere Fortschritte in der Verwendung der Hochofengase zur Unmittelbaren Krafterzeugung). F. W. Lürmann. Discussing especially the purification of the gas; also describing recent large engines. A paper before the Verein Eisenhüttenleute. Two articles, 10000 w. Stahl und Eisen—May 1, 15, 1901. No. 41143 each D.

Blast Furnaces.

A Water Cooled Blast Furnace Bosh. Axel Sahlin. Illustrated description of an arrangement designed by the writer. 3000 w. Ir & Coal Trds Rev—May 10, 1901. No. 41050 A.

British Isles.

The Industrial Progress of the Cleveland District. An account of the most important iron-producing centre of the British Isles, its ironstone resources and mining, system of working, mines, &c. Ill. 3600 w. Ir & Coal Trds Rev—April 19, 1901. No. 40637 A.

Charging.

Improved Method of Operating Charging Cones of Black Furnaces Electrically (Nener Elektrischer Antrieb für Gichtglocken). A. Schwarz. A device to replace steam by electric power, for use upon furnaces in which the gas is used in gas engines for the generation of electricity. 1000 w. Stahl und Eisen—May 15, 1901. No. 41145 D.

Competition.

Britain and Her Competitors in Iron and Steel Making. E. Phillips. A discussion of the causes of the wane of British supremacy in the manufacture of iron and steel with suggested measures for checking the decline. 5000 w. Engineering Magazine—June, 1901. No. 41198 B.

Corrosion.

The Corrosion of Iron and Its Prevention. H. Carroll Alford. Briefly considers the general theory of the formation of rust, and discusses the methods of preventing or arresting corrosion. 2200 w. St Louis Ry Club—April 12, 1901. No. 40593.

Crystallography.

On the Crystallography of Iron. F. Osmond and G. Cartaud. An account of extensive experimental investigations with numerous illustrations. 6000 w. Metallographist—April, 1901. Serial. 1st part. No. 40717 E.

Exports.

The Distribution of Iron and Steel Exports in 1900. Statistics relating to the principal exports of iron and steel and manufactures of the same from the government official report. 1800 w. Ir Age —May 16, 1901. No. 40913.

Furnace.

An Improved Type of Ingot Heating Furnace. F. H. Daniels. An illustrated description of the vertical heating furnace and its method of operation, with remarks on earlier types. 1800 w. Trans Am Soc of Mech Engrs, No. 911—May 1901. No. 41099.

Hardness.

Brinell's Method for the Determination of Hardness (Brinell's Verfahren zur Härtebestimmung). A discussion of the method of determining the hardness of steel by the area of the depression pro-

duced by a hardened steel ball under pressure in the testing machine. Two articles. 3500 w. Stahl und Eisen—April 15, May 1, 1901. No. 41142 each D.

Heat Treatment.

A Study of the Effect of Heat-Treatment on Crucible Steel Containing 1 per cent. of Carbon. George W. Sargent. Describes experiments and micro-structural investigations. Ill. 2000 w. Trans Am Inst of Min Engs—April, 1901. No. 40830 D.

Hydraulic Power.

See Mechanical Engineering Hydraulics.

Iron Sands.

See Mining and Metallurgy, Gold and Silver.

Japan.

The Steel Industry in Japan. Information in regard to the large steel works being erected by the Japanese Government. 800 w. Engng—April 19, 1901. No. 40643 A.

Metallography.

Practical Problems in the Metallography of Steel. J. O. Arnold. Discusses the use of micrographic analysis. 1400 w. Nature—April 25, 1901. No. 40686 A.

Open Hearth.

Notes on the Open Hearth Furnace (Notes sur le Four Martin). M. Clausel de Conssergues. A review of the improvements which have been made in the open-hearth furnace in the past ten years, especially with regard to capacity and economy. 3000 w. Soc Ing Civ de France—March, 1901. No. 41183 G.

"Phase-Doctrine."

Iron and Steel from the Point of View of the "Phase Doctrine." F. Osmond's remarks, and a note by H. le Chatelier accompanying a full French translation by Prof. Bakhuis Roozeboom's paper. Ill. 5300 w. Metallographist—April, 1901. No. 40718 E.

Phosphorus.

Segregation of Phosphorus in a Piece of Cold Rolled Shafting. Henry Fay. An illustrated report of an examination, microscopically and chemically, of a broken shaft showing an interesting case of segregation. 800 w. Metallographist—April, 1901. No. 40716 E.

Presidential Address.

Address of William Whitwell before the Iron and Steel Institute. Abstract. Reviews briefly the progress of the last century and discusses some of the problems awaiting solution, and other matters of interest to this industry. 4200 w. Col Guard—May 10, 1901. No. 41041 A.

Rails.

The Influence of Copper on Steel Rails and Plates. J. E. Stead and John Evans. Read before the Iron and Steel Inst. Gives results of previous investigations with report of experiments and conclusions. 2800 w. Ir & Coal Trds Rev—May 10, 1901. No. 41048 A.

Raw Materials.

The Raw Materials Used in the British Steel Industry. The present article gives information concerning the industry in the north of England. 1400 w. Ir & Coal Trds Rev—May 17, 1901. Serial. 1st part. No. 41247 A.

Researches.

Iron and Phosphorus. J. E. Stead. On investigations made of many hundreds of specimens, describing methods, and discussing results. Ill. 8500 w. Metallographist—April, 1901. Serial. 1st part. No. 40715 E.

Rod Mill.

The Passing of the Belgian Rod Mill. States the reasons for the looping type of rod mill giving way to the continuous mill. Ill. 2000 w. Ir Age—May 23, 1901. No. 41052.

Rolling Mill Practice.

A Comparison Between American and British Rolling Mill Practice. William Garrett. Read at the London meeting of the Iron and Steel Inst. A paper of great interest, blaming principally the owners and managers of British iron and steel works for the loss of British trade, and discussing points of importance. Also editorial. 1900 w. Engng—May 17, 1901. No. 40901 A.

Silicon.

Influence of Silicon upon the Strength of Cast Steel (Einfluss des Siliciums auf die Festigkeitseigenschaften des Flusstahls). E. Heyn. A report upon the experiments of Wahlberg in Sweden, as investigated at the Charlottenburg laboratory. 2000 w. Stahl und Eisen—May 1, 1901. No. 41144 D.

Steel Trust.

The Steel Trust on the Great Lakes. W. Frank McClure. An illustrated discussion of the transportation problem of the Great Lakes as affected by the steel industry. 3500 w. Rev. of Revs—May, 1901. No. 40654 C.

Titanium.

On the Influence of Titanium on the Properties of Cast Iron and Steel. Auguste J. Rossi. An account of experimental investigations and the conclusions. 5000 w. Trans Am Soc of Mech Engrs. No. 895—May, 1901. No. 41083 C.

Tropenas Process.

The Tropenas Steel Process. Edward L. Adams. Illustrated description of the installation of this process at the works of The Sargent Co., of Chicago Heights, Ill., with general remarks. 1800 w. Technograph, No. 15—1900-1901. No. 40995 D.

Urals.

The Tagil Iron District in the Urals (Der Eisenhütten bezirk Tagil im Ural). H. Tittler. A résumé prepared from the exhibits at the Paris Exposition of the Tagil district of Southern Russia, including description of mines, furnaces, and steel works. 4000 w. Stahl und Eisen—May 15, 1901. No. 41146 D.

MINING.

Drill.

The Davis "Calyx" Core-Drill. Illustrated detailed description of a rotating drill with annular cutter; also by means of the "calyx" it furnishes the chips cut from the rock in regular sequence as they are cut. 1200 w. Eng News—May 9, 1901. No. 40902.

The Fromholt Electric Diamond Drill (La Performatrice à Diamants et à Commande Electrique de M. Fromholt). M. Barbet. The tube containing the diamonds is revolved by electric power, while the pressure is given by the cooling water acting on a piston. 3000 w. Bull Soc d'Encour—April, 1901. No. 41122 G.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Explosions.

Government Tests of Maximite at Sandy Hook. An illustrated article reporting an interesting series of successful tests of a method of discharging shells charged with with a high explosive. 1300 w. Sci Am—May 25, 1901. No. 41073.

Exposition.

The Pan-American Exposition at Buffalo. I. The New York State Exhibit. Harriet C. Brown. An interesting account of the N. Y. state exhibits in the Mines Pavilion. 1700 w. Eng & Min Jour—May 18, 1901. Serial. 1st part. No. 41026.

Fans.

Rope Driven versus Direct Driven Colliery Fans. Francis T. Peacock. Read at meeting of the Canadian Min. Inst. Calls attention to the principal features to be considered in determining the type of driving, and discusses the objections and advantages of various systems. 1500 w. Eng & Min Jour—May 18, 1901. No. 41021.

Igniter.

Improved Electric Mining Igniter (Neue Dynamoelektrische Minenzundmaschine). L. Volf. A description of the Tirmann apparatus, in which the current from a portable hand-dynamo raises a platinum wire in the fuse to redness. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 27, 1901. No. 41158 B.

The New Tirmann Igniter and Delayed Shots. L. Volf, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Illustrated description of a dynamo-electric igniter and the method of working. 1200 w. Col Guard—May 3, 1901. No. 40852 A.

Mine Entrances.

Methods of Getting Into and Out of Mines. Arthur Edwin Haynes. Illustrated review of the methods thus far used. 2000 w. Engs' Year Bk, Univ of Minn—1901. No. 40934 C.

Mine Hoist.

Flat Hoisting Cables of Aloe Fibre (L'Emploi des Cables Plats en Aloes). C. Vertongen. Giving a very elaborate study of the stresses for deep hoists and computations for cables of uniform strength. Serial. Part I. 12000 w. 3 plates. Rev Univ des Mines—April, 1901. No. 41180 F.

The Koepe Mine Hoist (Ueber Koepe Förderungen). W. Müller. A description of an improved wire-rope hoisting system for deep mine shafts. 2000 w. 1 plate. Glückauf—March 23, 1901. No. 41152 B.

Mine Pump.

The Ehrhard and Sehmer Express Pump (Die Expresspumpe "Schleifmuhle" der Maschinen fabrik Ehrhard und Sehmer in Saarbrücken). J. Divis. An improved high-speed mining plunger pump, operating at 200-250 revolutions per minute. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 6, 1901. No. 41157 B.

Mining Plant.

See Electrical Engineering—Power Applications.

Mountain Transport.

Mining Transport Methods in the Higher Alps (Transmittel Hochalpiner Bergbane). A. Pfeffer. Illustrated description of mining railways in Tyrolese Alps. Two articles. 4500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 23, 30, 1901. No. 41155 each B.

Ore Deposits.

Problems in the Geology of Ore-Deposits. Prof. J. H. L. Vogt. Considers the original source, the relation between eruptive processes and the formation of ore-deposits, ore-solutions, etc. 15900 w. Trans Am Inst of Min Engs—April, 1901. No. 40829 D.

The Genesis of Ore-Deposits. Continued discussions of the papers of Messrs.

Van Hise, Emmons and Weed, etc., read at the Washington meeting. 7000 w. Trans Am Inst of Min Engs—April, 1901. 4 parts. No. 40825 D.

Ottoman Empire.

The Minerals of the Ottoman Empire. H. R. Jastrow. Notes some of the important minerals, and the hindrances to the development of mining. 1000 w. Eng & Min Jour—May 18, 1901. No. 41025.

Shaft Sinking.

Recent Shaft Sinking in the Ruhr District (Neuere Schachtfohrungen im Ruhrbezirk). L. Hoffmann. With details of the work of sinking shafts to depths of 450 to 1200 feet deep. 2000 w. 1 plate. Glückauf—April 27, 1901. No. 41153 B.

Smelting.

Modern Smelting Equipment. Illustrated description of the power plant, smelting furnaces, sampler and auxiliary buildings of the Granby Consolidated Mining and Smelting Co.'s copper works at Grand Forks, B. C. 1800 w. Mod Mach —May, 1901. No. 40769.

The Province of Pyritic Smelting. Herbert Lang. A reply to an editorial in this journal, wherein the ground was taken that pyritic process is not of general application. The writer thinks differently, and discusses the points brought up in the editorial. 3000 w. Eng & Min Jour—May 11, 1901. Serial. 1st part. No. 40895.

Stamp Mills.

The Duty of Stamp Mills in Crushing and Amalgamation. Courtenay De Kalb. Read before the Can. Min. Inst. Suggestions on important points, urging the frequent and critical study of the pulp. 2500 w. Can. Min. Rev—April 30, 1901. No. 40748 B.

Tunnels.

Tunnels and Tunnel Schemes. Arthur Lakes. The advantages and disadvantages of the adit and the crosscut; circumstances where the driving of each is advisable. Ill. 3600 w. Mines & Min—May, 1901. No. 40693 C.

Veins.

Metasomatic Changes in Veins. Frank D. Adams. Also Charles R. Keyes. Discussions of the paper of W. Lindgren, read at the Washington meeting. 2000 w. Trans Am Inst of Min Engs—April, 1901. No. 40827 D.

MISCELLANY.

Chemical Reaction.

The Forecast of Chemical Reactions from the Algebraic Signs of the Quantities of Heat Liberated. H. Le Chatelier. A study of the connection existing between chemical and calorific phenomena. 2000 w. Trans Am Inst of Min Engs—April, 1901. No. 40821 D.

Diamonds.

About Diamonds. Archibald Blue, in *Canadian Mining Reports.* Some account of diamonds found around the Great Lakes and in other parts of the United States; also in South Africa. Ill. 2000 w. Min Rept—May 2, 1901. No. 40787.

Education.

English Mining Schools. E. P. Dunn. Information concerning the different schools, the objects at which they aim, etc. 4000 w. Aust Min Stand—April 11, 1901. No. 41069 C.

Egleston.

Biographical Notice of Thomas Egleston, Ph. D., L. L. D. George F. Kunz. 7500 w. Trans Am Inst of Min Engs—April, 1901. No. 40831 D.

Estimating.

Valuing a Mining Property. Arthur Lakes. Some of the difficulties are discussed. 2000 w. Mines & Min—May, 1901. No. 40698 C.

Limestones.

Michigan Limestones and Their Uses. A. C. Lane. Map showing general distribution, with outline of the uses, and related information. 2000 w. Eng & Min Jour—May 25, 1901. Serial. 1st part. No. 41226.

Magnalium.

On Alloys (Ueber Legirungen). Prof. Klandy. An address before the Oesterr. Ing. und Arch. Verein on alloys in general and the aluminum-magnesium alloys in particular. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 30, 1901. No. 40702 B.

Mining Law.

The Legal Distinction Between a Mine and a Quarry. Gives a few cases illustrating the distinction recognized by British law. 1400 w. Col Guard—April 19, 1901. No. 40641 A.

Nickel.

Notes on the Oregon Nickel Prospects. Dr. A. R. Ledoux. Read before the Can. Min. Inst. An account of these deposits, their location, type, extent, geology, etc. Ill. 2000 w. Can Min Rev—April 30, 1901. No. 40749 B.

Petroleum.

Oil Fields of California. Arthur Lakes. An illustrated description of their location, formation, the quality of the product and extent of development. 5000 w. Mines & Min—May, 1901. No. 40697 C.

The Naphtha Industry at Baku (L'Industrie du Naphte à Bakou et l'Exploitation Nobel). G. Leugny. A description of the Nobel wells and refineries at Baku,

on the Black Sea. 1800 w. Revue Technique—March 25, 1901. No. 41107 D.

Russia.

The Mining and Metallurgical Industries of Southern Russia. H. L. Geissel. Illustrations of the largest blast furnaces ever built in Russia, with an account of the principal iron-producing district. 800 w. Min & Met—May 1, 1901. No. 41012.

Slimes.

Slime Treatment in the Galena-Joplin Lead and Zinc District. W. R. Crane. Illustrated description of sludge mills and the methods employed in them. 1200 w. Mines & Min—May, 1901. No. 40696 C.

Spain.

The Mineral Production of Spain. On the increase in production and development, especially of iron, coal, copper and salt. 1800 w. Engng—April 19, 1901. No. 40646 A.

Statistics.

The Mining Statistics of the World. Information from the General Report in Mines and Quarries, prepared by C. Le Neve Foster. 1400 w. Sci Am Sup—May 4, 1901. No. 40746.

Zinc.

The Zinc Deposits in Missouri, Kansas and Arkansas. An account of the production of this region, its value, and recent development. 1300 w. Min & Met—May 1, 1901. No. 41011.

Treatment of Zinc Sulphides. Describes the Ellershausen process. 900 w. Aust Min Stand—March 21, 1901. No. 40798 B.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in March. Detailed list and classified summary, with remarks. 4300 w. R R Gaz—May 3, 1901. No. 40736.

Freight.

The Conveyance of Freight on Electric Roads. A reprint of a part of an article by Alfred H. Gibbings, in *Traction and Transmission*, dealing with the problem of serving the region about Manchester, England. 1500 w. R R Gaz—May 3, 1901. No. 40734.

Inspection.

Inspection on the Manhattan Elevated Railway. A brief review giving some idea of the vigilance required to maintain such an oversight of the equipment as to prevent accidents. 1600 w. Ry Age—May 17, 1901. No. 41031.

Mileage.

Mileage: How Car Performance Can Be Improved. W. M. Prall. Considers a through car moving on a through contract, and a reorganized terminal service necessary. Also discussion. 4500 w. St. Louis Ry Club—May 10, 1901. No. 41266.

Tramways.

Tramways: Their Working and Accounts. R. S. Tresilian. On the value of accounts and statistics, with suggestions as to the form to be used. 2500 w. Tram & Ry Wld—April 11, 1901. No. 41057 A.

FINANCIAL.

Consolidations.

Industrial and Railroad Consolidations. A symposium. 1. A Great Danger to the Community. Russell Sage. 2. Their Advantage to the Public. James J. Hill. 3. Their Effects on the Steel and Iron Industry. C. M. Schwab. 4. What They Have Accomplished for Capital and Labor. Charles R. Flint. 5. Influence of the "Trusts" on Prices. F. B. Thurber. 6. The Outcome of Unintelligent Competition. James Logan. 21600 w. N Am Rev—May, 1901. No. 40752 D.

System of the United Power & Transportation Company. Considers reasons which have brought about the practice of pooling the interests of roads having no physical connection, explaining the organization, and giving the amount of capital owned by the company named, with illustrated description of some of the property. 3500 w. St Ry Jour—May 4, 1901. No. 40774 D.

Expenses.

Working Expenses of Electric and Cable Railways. Annual tables of the working expenses, receipts, etc., of the electric and cable railways of Great Britain, for which figures are available. 2800 w. Tram & Ry Wld—April 11, 1901. No. 41056 A.

Germany.

The Working Results of the Railways in Germany in 1899. Brief review of statistics concerning traffic, expenditures, etc. 1200 w. Engr, Lond—April 26, 1901. No. 40815 A.

Northern Pacific.

The Contest for Control of the Northern Pacific. A brief account of the cause of the recent collapse in the stock market. 1000 w. Ry Age—May 17, 1901. No. 41030.

Purchase.

The Southern's Absorption of the Mobile & Ohio. Information concerning the

contract, with a discussion of the condition of the property, the earning capacity and related matter of interest. Ill. 2500 w. Ry Age—May 24, 1901. No. 41236.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Brake Leverage. The first of a series of articles on this subject. The present number considers see-saw, force and direction, clockwise and counter-clockwise, equilibrium, lever arm, and movements. 2500 w. Loc Engng—May, 1901. No. 40617 C.

Cars.

All-Steel Box Car, A., T., & S. F. Ry. Illustrations and brief description. 600 w. Ry & Engng Rev—May 4, 1901. No. 40755.

A New Type of Car for Steam Roads. Illustrated description of a satisfactory car for suburban traffic. The window sash is double and of much larger size than usually employed, and so arranged that the sash slides upward into the roof, entirely out of sight when it is desirable to have the car open. 1200 w. Ry & Engng Rev —May 4, 1901. No. 40757.

45-Ton Box Car of the American Car & Foundry Co. Illustrated detailed description. 1000 w. R R Gaz—May 17, 1901. No. 40953.

Railway Carriages at the Paris Exposition, 1900 (Eisenbahwagen auf der Weltausstellung in Paris 1900). H. Bernstein. An illustrated review of the exhibits at Vincennes, with plans and views of the carriages of many countries. Serial. Part I. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 3, 1901. No. 41137 B.

66-Ft. Rail Cars and 38-Ft Gondola Cars. Illustrates and describes special cars for the Cleveland, Lorain & Wheeling Ry. 2000 w. Eng News—May 9, 1901. No. 40904.

Car Lighting.

The Lighting of Railway Cars. George D. Shepardson. Reviews the various methods that have been tried and their degree of success, and gives an account of the development of the electric light for this service. 2200 w. W Elect'n—May 18, 1901. No. 41034.

Compound Engines.

Why is a Locomotive Compounded? Roger Atkinson. Explains the manner in which compounding reduces losses from cylinder condensation. 2100 w. Loc Engng—May, 1901. No. 40616 C.

Draft Gear.

Draft Gear. Clement F. Street. A letter criticizing statements and theories in a communication from H. H. Westinghouse. 1200 w. R R Gaz—May 17, 1901. No. 40951.

Electric Traction.

Electric Traction for Heavy Railway Service. Edward P. Burch. The purpose of the paper is to show the present status of electric-railway engineering and to give reasons why the electric motive power will supplant the steam locomotive for heavy railway service. 5600 w. Engs' Year Bk, Univ of Minn—1901. No. 40937 C.

Fire-Boxes.

The Fire-Boxes of Locomotives. An editorial discussion of the construction, especially the side stays. 1700 w. Engr, Lond—April 19, 1901. No. 40651 A.

Kingsland System.

The Kingsland System of Electric Traction. An illustrated description of a contact system and the working of an experimental line. 3000 w. Prac Engr—May 17, 1901. No. 41242 A.

Locomotives.

Belgian Locomotives at the Exposition of 1900 (Les Locomotives Belges à l'Exposition de 1900). F. Barbier. Detailed description with weights, dimensions, etc., of the engines shown by Belgian works at Vincennes. 3500 w. 4 plates. Rev Gen des Chemins de Fer—March, 1901. No. 41148 H.

Brooks Locomotives for the Pere Marquette. Illustrated description of a wide fire-box consolidation freight locomotive, mogul freight engine, and a passenger engine of the Chautauqua type. 700 w. R R Gaz—May 3, 1901. No. 40735.

Dickson Grand Trunk Moguls. Illustration and dimensions of large locomotives. 300 w. Loc Engng—May, 1901. No. 40614 C.

Eight-Wheel, Wide Fire-box Passenger Locomotives. Illustrated description of engines for the D., L. & W. R. R. designed for culm burning. 500 w. Am Engr & R R Jour—May, 1901. No. 40-712 C.

Eight-Wheel Passenger Locomotive, D., L. & W. R. R. Principal dimensions with illustration. 400 w. Ry & Engng Rev—April 27, 1901. No. 40613.

Electrical Locomotives. Brief illustrated description of the locomotives on the City and South London Railway. 1400 w. Elec Rev, Lond—May 3, 1901. No. 40859 A.

Fire-Throwing from Locomotives. Robert Weatherburn. A discussion of the causes such as coal, firing, blast pipe action, cylinder posts, large and small tubes, size of smoke-box, fire grate, and mechanical appliances, all of which contribute to the emission. 3000 w. Engr, Lond—April 19, 1901. No. 40648 A.

German Locomotives at the Exposition of 1900 (Les Locomotives Allemandes à l'Exposition de 1900). R. Godfernaux.

Giving detailed descriptions of the various engines, with illustrations of valve gears and parts. Serial. Part I. 5000 w. 7 plates. Rev Gen des Chemins de Fer—April, 1901. No. 41151 H.

Heavy Mogul Passenger Locomotive, N. Y., O. & W. Illustrated description of an engine for heavy service. 700 w. Ry & Engng Rev—May 18, 1901. No. 41062.

Heavy Ten-Wheel Passenger Locomotives of the Cleveland, Cincinnati, Chicago and St. Louis Railway. Engravings and dimensions of simple engines doing remarkably fine work on the road named. 600 w. R R Gaz—May 24, 1901. No. 41229.

High Speed Compound Locomotives of the Northern Railway of France (Les Locomotives Compound à Grande Vitesse du Chemins de Fer du Nord). A review of the criticisms of Von Borries of the new express engines of the Northern Railway of France. 2000 w. Génie Civil—May 4, 1901. No. 41105 D.

Krauss Locomotives. Illustrated descriptions and particulars of special types of engines. 1500 w. Engng—May 10, 1901. No. 41043 A.

New "Prairie" Type Wide Firebox Locomotives. Illustrates and describes the chief characteristics of both simple and compound types. 1000 w. Am Eng & R R Jour—May, 1901. No. 40710 C.

Observations upon the Locomotives at the Exposition of 1900 (Quelques Observations Relatives aux Locomotives à l'Exposition de 1900). With especial reference to the weight and stability of the engines exhibited. Two articles. 5000 w. Revue Technique—March 25, April 10, 1901. No. 41109 each D.

Ratios of Total Weight to Heating Surface. F. F. Gaines. A letter called out by an article in the March issue of this same publication, suggesting a comparison of heating surface and horse power, and discussing the subject. 1700 w. Am Engr & R R Jour—May, 1901. No. 40714 C.

Six-Wheel Coupled Compound Locomotive; South Italian Railways. Illustrations of a new type of high-speed compound locomotive possessing some very remarkable features. Description to be given later. 150 w. Engng—May 17, 1901. No. 41260 A.

Tank Locomotive for the Indian State Railways; Northwestern Ry., Mushkaf-Bolan Division. Brief illustrated description. 400 w. Eng News—May 23, 1901. No. 41205.

Ten-Wheel Passenger Engines; Southern Pacific Ry. Brief illustrated description, with dimensions. 700 w. Eng News—May 9, 1901. No. 40903.

Ten-Wheel Wide Fire-Box Locomotive for the Wisconsin Central Railway. Illustrated description, with dimensions, of engines burning bituminous coal. 600 w. R R Gaz—May 10, 1901. No. 40907.

The Design of a Locomotive to Make a Speed of 200 Kilometres (Bedingungen für die Banart von Dampflokomotiven für 200 km. Geschwindigkeit). E. Fränkel. A discussion of the conditions to be met in designing an express engine to make a speed of about 125 miles per hour. 1200 w. Glaser's Annalen—April 15, 1901. No. 41116 D.

The Locomotive Exhibits at the Paris Exhibition of 1900. Storm Bull. An extensively illustrated review of the locomotives, with tabulated statistics. 6000 w. Trans Am Soc of Mech Engrs, No. 910—May, 1901. No. 41098 D.

The Midland Locomotive at the Exposition (La Locomotive de la Cie. du Midland à l'Exposition de 1900). A description of the engine, together with computations of the tractive power of locomotives with single driving axles. 2000 w. Revue Technique—April 25, 1901. No. 41114 D.

The Vanderbilt Locomotive Boiler. Information concerning this design, the service of those already in use, the number under construction, etc. 3900 w. R R Gaz—May 10, 1901. No. 40908.

Multiple Unit.

Some Notes on the History and Development of the Multiple-Unit System of Train Operation. George H. Hill. 5400 w. St Ry Jour—May 4, 1901. No. 40780 D.

The Sprague Multiple Unit System. Frank J. Sprague. The object of the article is to supplement a brief operative description of the system by details of the apparatus as constructed, with comments upon features peculiar to the operation. Ill. 7000 w. St Ry Jour—May 4, 1901. No. 40779 D.

Nottingham, Eng.

The Conversion of the Nottingham Street Railways. An illustrated account of the conversion from animal to electric traction, the construction, equipment, power station, etc. 3000 w. St Ry Jour——May 4, 1901. No. 40776 D.

Repairs.

Repairs to Bent Steel Car Bodies and Trucks. Report of committee, followed by discussion. 7300 w. Cent Ry Club—April, 1901. No. 40754 C.

San Francisco.

Notes on the Market Street Railway, San Francisco. An illustrated account of the organization, operation, equipment, and management. 3800 w. St Ry Jour—May 4, 1901. No. 40775 D.

Scotland.

Glasgow Electric Tramways. An illustrated account of the opening of the Pink-

ston power station, with the history of the undertaking and detailed description of the system. 3700 w. Elec Engr, Lond—April 26, 1901. Serial. 1st part. No. 40800 A.

Speed Recorder.

Electrical Speed Recording Instrument. Frank B. Rae. An illustrated description of an instrument designed by the writer for recording the performance of cars on electric, steam, or other roads, and which draws a reasonably true acceleration, running, drifting and braking curve. Also valuable for other uses. 900 w. Elec Wld & Engr—April 27, 1901. No. 40603.

Staybolts.

Firebox Staybolts of Manganese Bronze (Entretoises de Foyer eu Bronze Manganésé). M. Rodrigue. Results of experiments with manganese bronze staybolts in fireboxes of locomotives of the Northern Railway of France. 2000 w. Rev Gen des Chemins de Fer—March, 1901. No. 41149 H.

Stoker.

A Mechanical Stoker for Locomotives. Illustrated description of Kincaid's automatic stoker for locomotives, and an account of a trip with it in use. 1300 w. Loc Engng—May, 1901. No. 40615 C.

Storage Battery.

Storage Battery on the Cleveland & Chagrin Falls Railway. Illustrated description of a recently installed battery in a sub-station, where it was found almost impossible to operate the road between that point and the terminus. 1400 w. St Ry Jour—May 4, 1901. No. 40777 D.

Substation.

The Cleveland & Chagrin Falls Railroad's Storage Battery Substation. R. L. Palmer. A statement of facts concerning a recent storage battery installation. Ill. 900 w. Elec Rev, N. Y.—April 27, 1901. No. 40597.

Train Heating.

Air Pumps Exhaust for Passenger Train Heating. Report of a committee of the Air-Brake Assn., presented at the Chicago meeting. 2200 w. Ry Age—May 10, 1901. No. 40881.

Trains.

Good Roads Train, Illinois Central R. R. An illustrated account of a train loaded with road-making machinery sent out to construct sample stretches of public highway between New Orleans and Chicago. 1200 w. Ry & Engng Rev—April 27, 1901. No. 40612.

Tramway Feeders.

Feeders for Electric Tramways (Stromzuführungs-Einrichtungen Elektrischer Strassenbahnen). H. Bissinger. A paper read before the Berlin Railway Association, discussing especially the arrangement of feeders for surface contact systems. 5000 w. Glaser's Annalen—May 1, 1901. No. 41118 D.

Tramway Station.

The Power House of the Union Traction Company at Anderson, Ind. Illustrated description of a 3,000-K. W. station for operating an interurban system of 163 miles; describes mainly the design of the steam power plant, but outlines the electrical plant and system of distribution to eight sub-stations. 2700 w. Eng Rec—May 25, 1901. No. 41213.

Trucks.

Bogie Trucks for Electric Railway Cars. George L. Fowler. Illustrates and describes various designs. 2400 w. R R Digest—May, 1901. Serial. 1st part. No. 40942.

The Player Patent Improved Radial Truck. Illustrates and describes the construction of trucks used under a number of recent Brooks locomotives. 1500 w. Ry Mas Mech—May, 1901. No. 40664.

Water Scoop.

A New Track Tank Water Scoop. Illustrated description of an interesting design for the N. Y. C. & H. R. R. R. 900 w. Am Engr & R R Jour—May, 1901. No. 40711 C.

Wheels.

Cast Iron Wheels Under 50-Ton Cars. Editorial discussion of the breakages of chilled cast iron wheels, and their ability for service. 1200 w. R R Gaz—May 24, 1901. No. 41231.

Chilled Cast Iron Car Wheels at Present and in the Future. William Fawcett. Concerning the severe inspection and the requirements demanded, with description of an ideal car-wheel foundry. 3000 w. Ir Age—May 16, 1901. No. 40912.

The Proper Wheel Section for Interurban Railways. Discusses the conditions of service and the difficulties due to the use of the wheels on city streets, showing the necessity of having the flanges as deep and thick as the urban roads will permit. 1200 w. St Ry Jour—May 4, 1901. No. 40778 D.

NEW PROJECTS.

Australia.

A Trans-Australian Railway. An account of a projected line connecting the extreme west with the extreme east, by a railroad nearly a thousand miles in length. 900 w. Sci Am Sup—May 11, 1901. No. 40899.

Bagdad.

The Bagdad Railway. Comment on the project known as the German Bagdad Railway, which is already under way, and

the changes it will work. 1400 w. Engr, Lond—April 26, 1901. No. 40814 A.

China.

The Eastern Terminus of the Chinese Eastern Railroad. Jasper Whiting. Information concerning the southern terminus of the Chinese Eastern (Manchurian) Railroad, at Dalnie, near Port Arthur. 2000 w. R R Gaz—May 10, 1901. No. 40905.

Ecuador.

Railway Development in Ecuador. An account of very important work of railway extension now being carried to completion. 1300 w. Transport—May 10, 1901. No. 40969 A.

Paris.

Mechanical Traction in Paris. This first article explains the difficulties and conditions existing and the new policy of the Municipal Council. Also the steps taken by the Campagnie Générale des Omnibus. 3400 w. Engr, Lond—April 19, 1901. Serial. 1st part. No. 40647 A.

Thanet Tramways.

The Isle of Thanet Tramways. An illustrated detailed description. 2400 w. Elect'n, Lond—April 19, 1901. No. 40634 A.

Trans-Siberian.

The Trans-Siberian Railway. Reviews the history of this great undertaking, giving map, and tabulated summary of costs, details, and other matters of interest. 3500 w. Engng—May 3, 1901. Serial. 1st part. No. 40845 A.

Tubular Railways.

Tubular Railways. Editorial discussion of the advantages of these railways in metropolitan districts. 2200 w. Engr, Lond—May 17, 1901. No. 41253 A.

Uganda.

The Railways of Africa (Afrikanische Eisenbahnen). Col. Gerding. An address before the Berlin Railway Association, describing the progress of the Uganda railway as seen by the writer during a recent visit. 2500 w. Glaser's Annalen—May 15, 1901. No. 41119 D.

PERMANENT WAY AND BUILDINGS.

Boston Elevated.

The Boston Elevated. An illustrated description of a few features of interest in this recently opened railway system. 1100 w. St Ry Rev—May 15, 1901. No. 40960 C.

Embankments.

Some Notes on the Classification of Material and Shrinkage in Embankments. C. E. Crownover. Concerning methods used on the Union Pacific in connection with difficult work in Wyoming. 1600 w. Engs' Year Bk, Univ. of Minn.—1901. No. 40935 C.

Freight Station.

Freight Distributing Station, Chicago Terminal Transfer R. R. Illustrates and describes a receiving station conducted on a novel plan. 1000 w. Ry & Engng Rev—April 27, 1901. No. 40610.

Grades.

Grade Reduction. E. Holbrook. Discusses points in relation to the physical and business conditions which aid in determining the benefits to be derived by grade reductions. 5000 w. Ry Age—May 3, 1901. No. 40784.

Improvements.

Improvements on the Pennsylvania Railroad. An account of improvements recently made, or soon to be made, taken from the last annual report. 1200 w. R R Gaz—May 3, 1901. No. 40733.

Light Railways.

The Isle of Thanet Electric Light Railways. An illustrated sketch of lines recently opened. The station provides light, power and traction service. History and description. 4200 w. Tram & Ry Wld—April 11, 1901. No. 41055 A.

New York Central.

The Engineering Department of the New York Central. The present article deals with bridges, and track elevation. Ill. 1400 w. R R Gaz—May 17, 1901. No. 40955.

Oiled Roads.

Oil on Railroads and Wagon Roads. D. S. Harrison. Report of the manner of applying and the advantages resulting. 1400 w. Technograph, No. 15—1900-1901. No. 40997 D.

Paris.

The Tramways of the East and West Companies of Paris (Les Tramways de Penetration des Compagnies de l'Est et de l'Ouest Parisiens). H. Martin. An illustrated description of recent installations. The overhead trolley is used in the suburbs, and the Diatto contact system in Paris. 3000 w. 1 plate. Génie Civil—May 4, 1901. No. 41103 D.

Pyrenees.

The Electric Railway of Pierrefitte-Cauterets (Le Chemin de Fer de Pierrefitte-Cauterets). P. Médebielle. Illustrated description of electric railway in the Central Pyrenees, with hydro-electric power station. 3500 w. 2 plates. Rev Gen des Chemins de Fer—March, 1901. No. 41147 H.

Rail Bonds.

Bonds, Bonding and Bond Testing Methods. Albert B. Herrick. A discussion of methods and types of bonding and testing. 3300 w. St Ry Rev—May 15, 1901. No. 40957 C.

Railway Construction.

Heavy Railway Construction in Wyoming. Discussion of paper by J. I. Boggs. 1000 w. Pro Am Soc of Civ Engrs—May, 1901. No. 41271 E.

Rapid Transit.

Some Features of the New York Rapid Transit Tunnel. Illustrates the conditions at 34th St., which give eight tracks at three different levels, and calls attention to progress and interesting features. 1900 w. Sci Am—May 25, 1901. No. 41074.

Round-Houses.

Round-House Facilities. General discussion by members. 7300 w. Cent Ry Club—April, 1901. No. 40753 C.

Shops.

Locomotive and Car Shops. An illustrated description of the new shops at Fond-du-lac, for the Wisconsin Central Railway. 1500 w. Am Engr & R R Jour—May, 1901. No. 40713 C.

Signals.

Automatic Electrical Block Signal System (Selbstthätigen Elektrischen Zugdeckungseinrichtung). H. Sumpf. A description of the system of L. Jacob, of Casse, with plate showing the construction in detail. 2000 w. 1 plate. Glaser's Annalen—May 15, 1901. No. 41120 D.

Electrically Operated Railway Signals. F. J. Postel. Reviews the systems of signaling used, describing especially the applications of electricity to the operation of signals. 3000 w. Technograph, No. 15—1900-1901. No. 40998 D.

Safety Apparatus for Trains (Appareils de Securité des Trains). J. Prouteau. A description of the Primat system for furnishing an automatic rear-guard signal. 1800 w. Revue Technique—April 10, 1901. No. 41113 D.

Track circuits in Railway Signaling Plants. A. G. Shaver. Discusses briefly important points in track circuit work. 600 w. Eng News—May 16, 1901. No. 40945.

Station.

Sullivan Square Station of the Boston Elevated. Illustrated description of an unusually fine station for the use of passengers paying only five cent fares. 600 w. R R Gaz—May 3, 1901. No. 40732.

Street Shed.

A Railroad Depot Street Shed at Des Moines. Illustrated description of a 45-ft. shed for a platform, where it was necessary to have an attractive structure. 800 w. Eng Rec—May 18, 1901. No. 40964.

Terminal.

The New York Central's Boston Terminal. Brief illustrated account of proposed improvement in Boston terminal facilities. 400 w. Ry Age—May 17, 1901. No. 41032.

Track Elevation.

Track Elevation in Chicago. An account of work completed and in progress of raising 745 miles, at a cost of over $38,000,000. 1200 w. Ry Age—April 26, 1901. No. 40595.

Track Elevation in Chicago. An illustrated description of the work at the Eighteenth street section of the Chicago & Alton, Santa Fe and Illinois Central lines. 1700 w. Ry Age—May 10, 1901. No. 40880.

Tramways.

Stone Tramways. Describes a system of stone tramways development, known as the Heytor tramway, in Devonshire, Eng., opened Sept. 16, 1820, and others of similar construction. 1900 w. Engr, Lond—April 19, 1901. No. 40650 A.

Trestle Filling.

The Dale Creek Fill, Union Pacific R. R. Gives illustration and describes the methods of work. 1000 w. Ry & Engng Rev—May 4, 1901. No. 40756.

Tunnels.

The Ventilation of Elkhorn Tunnel—Norfolk & Western Railway. Charles S. Churchill. An illustrated description of the tunnel, with details of the method employed which consists of an injector and machinery for forcing the air in at one end of the tunnel. 2700 w. R R Gaz—May 10, 1901. No. 40906.

Vicksburg, Miss.

Alabama & Vicksburg Improvements in Vicksburg, Miss. Illustrated description of changes made, with explanation of the causes that led to them. 2000 w. Ry & Engng Rev—May 18, 1901. No. 41061.

TRAFFIC.

Grain Transport.

The Railways of France and the Transport of Cereals (Les Chemins de Fer Français et les Transports de Céréales). R. Bloch. A general review of the grain traffic of France and its distribution among the various railways. 5000 w. Rev Gen des Chemins de Fer—April, 1901. No. 41150 H.

Interchange.

Reports of Committees on Revision of the Rules of Interchange. Reports and general discussion. 16500 w. W Ry Club—April, 1901. No. 40971 C.

Statistics.

Railroad Statistics and Their Practical Use. A. D. Parker. Read before the Rocky Mt. Ry. Club. Also editorial criticizing some of the ideas advanced. 3600 w. Ry & Engng Rev—May 25, 1901. No. 41235.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to JOHN R. DUNLAP, PUBLISHER.

Machine Design.

The Elements of Machine Design. Part I. General Principles, Fastenings, and Transmissive Machinery. By W. Cawthorne Unwin, F. R. S. Price 7s. 6d.; pp. 555. Price, $2.50. Size, 5 by 7 in. London, New York, and Bombay; Longmans, Green & Co.

A new and revised edition of Professor Unwin's well-known treatise on machine design, more than 100 pages of new matter having been added, and some older material omitted and condensed. The present volume treats of materials of construction, methods of fastening, and the machinery of transmission. The subject of engine details is reserved for the second volume, in preparation.

Refuse Disposal.

The Economic Disposal of Towns' Refuse. By W. Francis Goodrich. Size, 6 by 9 in.; p. 340. Price, 10s. 6d.; $3.50. London: P. S. King & Son. New York: John Wiley & Sons.

An excellent review of the evolution and development of refuse-destruction, including sorting, incineration, utilisation for steam raising, and details of practice in Great Britain, America, and the Continent. Illustrations of many destructor plants are given, and data and results of operation, together with tests of steam-raising plants and general information as to costs and revenues.

Water Towers.

Towers and Tanks for Water-Works. The Theory and Practice of Their Design and Construction. By J. N. Hazlehurst. Price, $2.50. Size, 6 by 9 in.; pp. 216. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

Devoted especially to the design and proportions of iron and steel standpipes and water-tanks, discussing the materials, proportions, stability, and construction. The mechanical principles involved are explained and methods of calculation given, together with a discussion of shop practice, erection, and paint protection of the completed structure.

Steam Heating.

A Practical Treatise upon Steam Heating. Methods and Appliances for Warming Buildings, Heating Water, and Cooking by Steam. By Frederick Dye. Size, 6 by 9 in.; pp. 238. Price, $4.50. London: E. & F. N. Spon. New York: Spon & Chamberlain.

A general treatise upon heating by low-pressure, high-pressure, and exhaust steam, including the general principles of the distribution of heat in buildings, details of apparatus, and methods of computing sizes and capacity of apparatus.

Filtration.

Walter Filtration Works. By James H. Fuertes. Size, 5 by 7½ in.; pp. 280. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

A general examination of the methods of purification of public water supplies by the processes of sedimentation, and filtration, with especial reference to slow sand filtration, and of the use of rapid mechanical filters. Many examples of installations in America and Europe are illustrated and described, together with the details of operation, cleaning, and performance.

Photography.

Manuel Pratique de Photographie au Charbon. Par Edouard Belin. Size, 5 by 7 in.; pp. 87. Price, 2 francs. Paris: Gauthier-Villars.

A treatise on the method of making carbon photographic prints, with an examination of the chemistry of the process, and directions for the preparation of the paper, as well as the use of the prepared papers of commerce.

Induction Coils.

Induction Coils, How to Make, Use, and Repair Them. By H. S. Norrie (Norman H. Schneider). Second Edition, Revised and much Enlarged. Size, 5 by 6½ in.; pp. 269. Price, $1.00. New York: Spon & Chamberlain. London: E. & F. N. Spon, Limited.

Giving detailed information as to the construction of Ruhmkorff, Tesla, and medical coils, and their use in Roentgen radiography and wireless telegraphy. Practical information on the construction of primary and secondary batteries is appended, and numerous interesting experiments described.

Pocket Book.

Electric Sparks. By James A. Beaton. Size, 2½ by 5½ in.; pp. 272. Price, 75 cents. Chicago: Laird & Lee.

A handy vest pocket-book of data relating to electricity, including units, measurements, telegraphy, telephony, dynamos and motors, lighting, etc., etc.

Canal.

Report on Barge Canal from the Hudson River to the Great Lakes. Edward A. Bond, State Engineer. Size, 6 by 9 in.: pp. 1020, with portfolio of maps and profiles. Albany: James B. Lyon, State Printer.

A very valuable public document, containing a mass of information as to the proposed barge canal routes, together with tables as to rainfall, water-supply, locks and other hydraulic and hydrographic data. Much of this information has never been before published and will doubtless be of value for many other purposes than that for which it was prepared.

Commerce.

Commercial Relations of the United States with Foreign Countries during the Year 1900. Bureau of Foreign Commerce, Department of State. Size, 6 by 9 in., pp. 1231. Washington: Government Printing Office.

Volume I. of this important Government publication contains a review of the world's commerce for Africa, America, Asia, Australasia, and Polynesia, with much useful information as to the commercial practice of various countries, and very full tables of exports and imports.

Engineering Practice.

Engineering Practice and Theory. By W. H. Wakeman. Size, 5 in. by 7 in. Price, $1.00. New Haven: W. H. Wakeman.

A handbook for the instruction of all who have to do with steam engines, explaining the details of their care and practical operation, together with a series of questions to aid in the preparation for examination.

Firing.

The Practical Guide for Firemen. By W. H. Wakeman. Size, 4½ in. by 6 in.; pp. 65. Price, 50 cents. New Haven: W. H. Wakeman.

A guide for the instruction of firemen, including the daily routine, conduct in emergencies, testing, cleaning, smoke-prevention, etc.

A subject too often neglected is discussed in a practical way for practical men.

Internal Navigation.

La Navigation Internationale et ses Interests. Par Lindon W. Bates. Size, 8 in. b. 10 in.; pp. 54. Numerous plates. Paris: Imprimerie Paul Dupont.

A paper upon the harbors and canals of the world, and the best methods for their improvement, with especial reference to the hydraulic suction dredge. Presented at the VIII. International Congress of Internal Navigation, Paris 1900.

Harbor Improvement.

Concurso para la Construccion y Explotacion de un Puerto Comercial en la Ciudad del Rosario. Size, 8 in. by 12 in. Four volumes, eight portfolios of plates. Buenos Aires: Ministerio de Obras Publica.

The complete plans and specifications of the proposed works for the improvement of the harbor and port of Rosario, the shipping port of Buenos Aires. These include details of the competition and form a most valuable study of harbor improvement works, having been prepared under the supervision of Mr. Elmer E. Corthell, the well-known American engineer.

IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

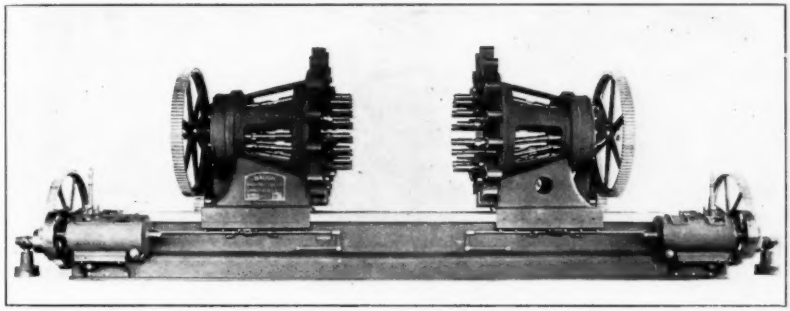
Horizontal Multiple Spindle Drill.

THE cut herewith shows a new style multiple spindle drill which has just been brought out by the Baush Machine Tool Co., of Springfield, Mass., making a valuable addition to their already large line of both vertical and horizontal multiple spindle drills.

In this machine each head carries sixteen spindles, adjustable to any layout from a 14" to a 30" circle, with an independent spindle adjustment for different lengths of drills.

size machines 6 ft. between points of drills, though this can be increased by making the bed longer, at a slight additional cost.

The Baush Machine Tool Co. build these machines with both the single and double head, in sizes from four to twenty-four spindles, up to and including 1½" drills. For work that requires drilling at both ends, such as steam or pump cylinders, short pipe, or work of a similar nature, it will be found a most serviceable and economical tool and one which is meeting with a great deal of favor among the trade.



The joints used are a new design and have proved themselves, after exhaustive tests, to be far superior to any universal joint on the market.

The automatic attachment is another of the new and prominent features of this machine. It can be set to drill holes of any desired depth, with a quick return. This permits of great ease and rapidity in operating the head, besides relieving the workman of much unnecessary handling. Though it is automatic, it can be handled by hand with equal facility.

The two heads can be run independently or together, according to the class of work required, and will take in on the regular

Heavy Finishing Grinder.

THE designer of the machine herewith illustrated, C. H. Norton, has believed for a long time that the grinder would be found an economical factor of production on much larger work than it had yet been used for.

Mr. Norton believes that where grinding is to be done rapidly and at the same time well, a machine to do it must be heavy and powerful, far beyond what is generally imagined to be necessary; and accordingly the machine under consideration, which is for grinding solid work up to 8 inches diameter, 8 feet long, weighs about 9,000 pounds and carries emery wheels 24 inches diameter, 2-inch face, driven by a belt 4 inches wide,

running on a spindle pulley, the largest step of which is 10 inches diameter. This obviously means that a good deal of work can be done with the machine if only pro vision can be made for rigidly supporting the work and wheel arbor, and special pains have been taken to do that thoroughly.

The bed of the machine is a single massive casting which rests upon three points, so that danger of disturbances of alignment by settling of floors or foundations is eliminated. One of these points is directly under the wheel support, while the other two are in front, near the projecting flanges seen in the view of the machine, forming nearly an equilateral triangle. This accounts for the bed being cut under so much at the ends; it being believed that it was better to support it at or near the points at which there is least deflection by weight and make the projecting ends sufficiently stiff to ensure their deflection being imperceptible. The bed is very heavily ribbed and trussed inside, to carry the weight to the points of support without deflection.

The swivel table, upon which the head- and foot-stock are mounted, is approximately of triangular section, forming a permanent water guard and a support for the head- and foot-stocks, one of the ways upon which they are clamped being near the base and the other at the top; the clamping bolt taking hold of the slot which is midway between the bearing surfaces. The upper edge and front face of the swivel table are utilized for clamping to them the rests which support the work, and curiously enough, experience shows that the heaviest work requires these rests as well as the lightest; heavy shafts seeming, when not so supported, to set up vibrations fatal to the accomplishment of rapid and accurate work.

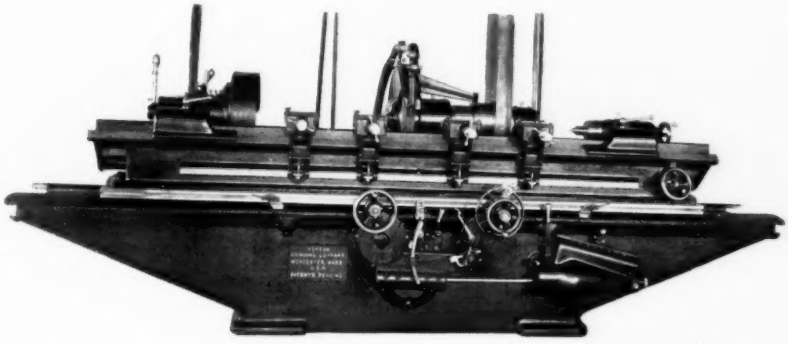
One of the points considered to be important in such a machine is that it should have a great range of speed for the rotation of the work and for the feed. The work is driven by an eight-step pulley which is on a shaft having a pinion that engages with gear teeth cut on the periphery of the spindle whirl; the object being not only to get the necessary speed changes for the work, but also to do the driving with a narrow, high-speed belt, which, because it is narrow and fast running, will retain its place on the pulley no matter how quickly the table of the machine may be moved. This belt runs over a plain drum overhead, so that its speed is always the same, and it runs through guide forks connected with a lever, by which it is shifted from step to step of the pulley. The "risers" between the pulley steps are not vertical or radial as usual, but are at an angle of 45 degrees, so that the belt readily mounts them, and there is an automatic take-up for the belt, by which its tension is maintained uniform, and thus a change of speed involves simply the movement of a lever, and nothing more.

For the feed or movement of the platen upon the bed a similar stepped pulley is provided, and this pulley is under the cover seen in front of the bed at the right. The belt runs on this pulley, passing through the opening seen. It also is driven from a plain drum overhead, and the idlers shown maintain a uniform tension upon it. This belt also is shifted from step to step of the pulley, by a lever which is shown above the pulley cover; and, in addition, the vertical lever at the left, when moved, changes the table movement in the ratio of 3 to 1 by means of gears and a clutch. This last-mentioned lever is designed particularly for reducing the table movement for the final passage of the wheel over the work, to give the finish. The rate of table movement in this machine is relatively very high; the intention being to advance the work the full width of the wheel at each rotation of the work; which means, of course, that where, for instance, a ground surface is 4 feet long and a wheel with 2-inch face is being used, the wheel passes over it while the work makes 24-inch turns. This is a vital point in rapid grinding. It enables the entire face of the wheel to be utilized, and experience with wheels used in this way shows that they retain their shape indefinitely—*i. e.*, they remain flat across the face; and where, during the progress of a job, the wheel shows signs of being slightly out of true, a small change of its speed always corrects that untruth; this change being provided for by the stepped pulley on the wheel spindle.

There is also an automatic feed for the wheel toward the work; this feed being effected by the large ratchet wheel seen in front of the machine; the pawl (shown thrown to the left and disengaged),

having, when in operation, a vertical, reciprocating motion given it by the slide to which it is pivoted, and this slide is moved varying distances by a rack and pinion motion, which in turn derives its motion from the curved bar seen in front near the center of the machine; the connection to this being movable to secure different amounts of wheel advance. An adjustable guard on the rim of ratchet wheel can be set to stop the automatic advance of the wheel at any desired point by preventing the pawl from engaging the tenth of the wheel.

When the knob at the center of the cross-feed hand-wheel is tightened, the wheel is moved toward the work by the small crank-handle moving around the small dial shown at the top of ratchet-wheel. This dial has eight holes through it, equally spaced, and



an index pin attached to the crank-handle can engage any one of these holes. A movement of the crank from one of these holes to the next one causes a reduction of the diameter of the work of 0.00025 inch (one-quarter of a thousandth of an inch); and, incredible as it may seem, it is a fact that such is the perfection of the mechanism that has been developed for this purpose, that the heavy slide and wheel-rest are by it actually started in motion, moved one-eighth of a thousandth and brought to rest again with accuracy. When the knob is loosed the wheel-slide is moved direct by the hand-wheel.

The table-reversing lever and dogs cannot be broken or injured by running the table against them by hand, because when thus handled they pass in either direction without harm, and when the automatic movement is resumed they perform the reversing function as before.

The Norton Emery Wheel Co., Worcester, Mass., will be glad to furnish more detailed information.

Electric Motor Controller.

THE illustration on the following page shows an electric motor controller for use with machine tools, printing presses and like machinery and designed to be controlled by one or more push buttons located wherever it may be convenient. These controllers are made for either reversible or non-reversible motors and in sizes from 1 H. P. up. The illustration shows a 3 H. P. reversible controller with a single push button designed to be placed upon a lathe, the controller being installed overhead. There are six different speeds in each direction and this device will materially increase the amount of work which can be turned out by a given tool.

The advantages of direct electric driving are considerable, and the manufacturers, Messrs. Schureman & Hayden, 138 South Clinton street, Chicago, will furnish detailed information upon request.

Improved Screw Thread Gauge.

THIS gauge is new in design and furnishes a correct standard to which tools can be

ground to cut threads, of a uniform angle, to take the place of square threads.

The thread has the same depth as the square thread; but, as the sides are at an inclination of 14½° (29° included angle) this form of thread is stronger, and is now generally adopted in cutting worms.

This gauge is made of the best steel, tempered, adjusted and all angles accurately tested after hardening. The accompanying diagram will give an idea of the method of using the improved 29° screw thread gauge.

At A is shown the method of gauging the angle of the tool irrespective of the pitch, the slot having an included angle of 29°; and at *C* the angle is used, when grinding off the point of the tool to the proper width, to test the angle of the side with the point.

The angular notches on the side of the gauge are the proper width for the points of tools for the various pitches, as indicated at *B*.

When setting the tool, the end *D* can be used against the face plate, or the side *E* against the blank to be threaded, the tool being placed as shown at *C*.

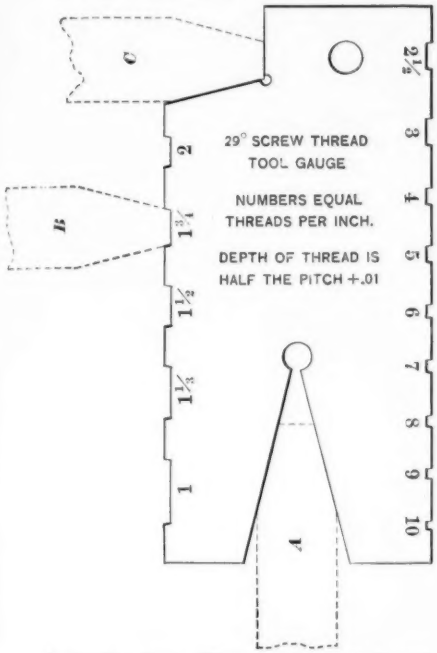
Made by the Brown & Sharpe Mfg. Co., Providence, R. I.

Industrial Notes.

The equipment of the great shipbuilding plant of the Fore River Engine Co. at Quincy Point, Mass., exemplifies in marked degree the varied applications of the fan blower. Draft for its boilers is produced by an induced draft fan drawing the gases directly from the uptake flue and discharging them through a small stack extending only a few feet above the roof. Under the forced system fan draft is likewise employed for creating the necessary intensity of combustion in the heating furnaces and forges while the smoke is removed from the forges through hoods communicating with an exhaust fan. All buildings are heated by the hot blast system by means of which a fan forces the heated air through distributing pipes and delivers it along the walls and above head level. Notwithstanding the exposed position of the buildings, last winter was passed with perfectly uniform internal temperature throughout all of the buildings. The entire equipment of blowers and heating apparatus was installed by the B. F. Sturtevant Co., of Boston, Mass.

The American Blower Co. of Detroit, Mich., recently closed a contract for the

entire heating, ventilating, drying and mechanical draft plants for the new works of the New York Glucose Co., now being erected at Shady Side, N. J., opposite West Ninety-sixth street, New York City. There are fourteen distinct heating plants and five starch drying plants. The heating apparatus contains a total of about 100,000 feet of surface, fifteen steel plate fans, varying in size from 80" to 140" and five



large disc fans. There is also a 360" steel plant fan for the forced draft plant. At present fourteen boilers are being installed, but eventually there will be eighteen, aggregating 9,500 horse-power output in steaming capacity. This fan is to provide the blast necessary for the proper combustion of the fuel, which will amount to nearly 50,000 pounds of anthracite "buckwheat" coal per hour.

The H. W. Johns Mfg. Co. recently secured a contract for covering all the new work installed in the plant of the St. Regis Paper Co., Watertown, N. Y., in which asbestos fire covering felt was used, and they have also secured the contract for covering the new boilers installed in the Iron Steamboat Co.'s boats *Columbia, Sirius* and *Taurus,* asbestocel sheets and asbestoc cement being used. This company is getting up a neat little pamphlet on asbestocel pipe covering, sheets and paper, and it is expected to be ready very shortly. One of the pamphlets can be had by addressing The H. W. Johns Mfg. Co., New York.

The sales of the Detroit Graphite Mfg. Co. of Detroit, Mich., of "Superior" graphite paint show an increase of 50 per cent. over a corresponding period of last year.

The Sullivan Machinery Co. of Chicago have recently become successors to the M. C. Bullock Mfg. Co., and in future will manufacture the complete line of diamond drills, rock drills and mining machinery formerly put on the market by the two concerns. Since this change in management the Sullivan Co. have transferred their western works into the larger and more commodious building formerly occupied by the Bullock Co. A line of Corliss air compressors and Corliss hoists of all sizes is now being built, which has necessitated the complete overhauling and enlarging of this plant. Two new buildings have lately been erected and are now almost ready for use. The Sullivan Co. have recenty extended their western agencies to the Pacific coast, and now in addition to the Denver office in charge of Mr. R. D. Hunter, a branch office has been opened in Spokane, Wash., under the management of Mr. M. J. Ready.

The Stanley Electric Manufacturing Co. of Pittsfield, Mass., have found it expedient to establish another sales office in the south, this one at Winston-Salem, N. C. Mr. F. A. Barr is district manager. The Stanley Company's other southern office is at Rock Hill, S. C., in charge of Mr. F. C. Whitner.

The new process Raw Hide Co., Syracuse, N. Y., has recently shipped one of its new process noiseless pinions to Germany to be used on the private yacht of Kaiser Wilhelm.

The contract for a complete central air compressing plant has been awarded to the McKiernan Drill Co. by Shanahan Woolfolk & Co., South Framingham, Mass., who have secured a large contract from the

Metropolitan Water Board of Boston, Mass., for an aqueduct consisting of two tunnels, etc. The amount of the contract secured by the McKiernan Drill Co. is in the neighborhood of $25,000.

The Massachusetts Fan Co. of Boston has secured its share of work for this season. Its new departure in the line of hot blast apparatus, steel plate fans and blowers is meeting with considerable success. They at present are installing this line of apparatus and their well-known Davidson fans in the Sayles bleacheries, Providence; Smith Paper Co., Lee; Nonantum paper mill, Delaware; the John Hoberg paper mill of Green Bay, Wis.; John T. Moore & Son paper mill, Bellows Falls; F. W. Bird & Son paper mill, Walpole; Weston paper Co., Terre Haute, Ind.; Waxahachie cotton mill, Waxahachie, Texas; Massachusetts cotton mills, Lowell; fans for veneer dryers in Rheinlander, Wis., and Grand Rapids, Mich.; twelve electric fans in the post office in Boston; in the Worcester Insane Asylum; Shredded Wheat Co., Niagara Falls, and Agassiz Museum, Harvard College. They are also building a large steel plant blower for a grammar school in Lawrence and a steel plate heating fan for the Semitic Museum, Harvard College, and another for the Stillman Infirmary, Cambridge, together with their electric fans.

The A. S. Cameron Steam Pump Works of New York have a very fine exhibit of their pumps at the Pan-American Exposition which should interest all engineers. The exhibit is in charge of Mr. P. E. Leahy, president of the National Association of Stationary Engineers, and consulting engineer for the Cameron Works. The exhibit consists of eight of the Cameron pumps showing a variety of styles of the direct-acting type and including the following: The "regular" type for general service, the special "boiler feeder" pump, the vertical piston mining pump, vertical plunger sinking pump, the horizontal plunger station mining pump, cut in sections for mule back transportation in mountainous countries, the sectional plunger sinking pump, the vertical engine and deep well pump for artesian wells, and a pump cut into sections to illustrate the mechanism and principle of operation of the Cameron type of pump. The exhibit is shown in the Machinery Division of the Transportation Building in Block No. 25.

The Michigan College of Mines is planning for the erection of two much needed buildings, which have been provided by the Legislature of the State. One of these is to be for the Department of Civil and Mining Engineering, and the other for the Departments of Chemistry and Metallurgy. The mining engineering building will provide mining and hydraulic laboratories, together with lecture and class rooms, all equipped with modern appliances. The amount allowed for its construction and equipment is $42,500. The building devoted to chemistry and metallurgy with its equipment will cost $35,000. Its laboratories will be fitted up in accordance with modern ideas of lighting, plumbing and ventilation. The appropriation provides also for an addition to the present engineering building which will accommodate the course in blacksmithing. The equipment of the electrical laboratory will be extended and the central heating plant enlarged, to take care of the added buildings.

In view of the large number of students who will visit the Pan-American Exposition, the International Correspondence Schools, Scranton, Pa., have established an information bureau at their Buffalo office. Arrangements have been made securing accommodations both in hotels and private families during the Exposition. The Schools state that no rooms can be secured at less than $1.00 per night for each person and that persons wishing rooms held for them must forward remittance to pay for the time the rooms are wanted. The information bureau is conducted free of charge. All correspondence intended for the information bureau should be addressed to the International Correspondence Schools, Ellicott Square Building, Buffalo, N. Y.

A Mark XII Columbia runabout, owned by Mr. George Howard, treasurer of the National Safe Deposit, Savings and Trust Company, of Washington, D. C., and equipped with a new Exide battery, made the trip from Washington to Baltimore, on one charge, recently, under conditions that made the trip a remarkable one from the point of battery endurance. An automobile

run had been planned from Washington to Baltimore, but the falling rain and heavy conditions of the roads kept every vehicle from starting, except the Columbia runabout in which were Otto Jacobi and Chas. Baxter. When Baltimore was reached the cyclometer indicated a run of 44 miles, and eight miles of this distance was over roads that required an excessive amount of current to keep the vehicle in motion. This section of the road is described as one of layers of mud and sand over rough fillings of broken stone; in some places the mud was so deep that the motor was covered. There was sufficient current left to carry the vehicle several miles around Baltimore when the vehicle reached that city, bringing the total mileage on one charge of the batteries to 50. The conditions of the roads prevented any attempt at speeding.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

JOHN F. ALLEN, New York, N. Y.—A small catalogue illustrating in detail a number of portable pneumatic percussion and compression riveting machines for structural, elevated railroad work, bridge building and boiler making.

ROBINS CONVEYING BELT CO., New York, N. Y.—A handsome catalogue illustrating many installations of the Robins belt conveyor for coal handling.

AMERICAN HOIST AND DERRICK CO., New York, N. Y.—The edition for 1901 of a very extensive catalogue of hoisting engines, many types of hoists and derricks, locomotive cranes, elevators, etc.

CHANDLER & TAYLOR CO., Indianapolis, Ind.—(*a*) A small catalogue in colors, illustrating a line of automatic cut-off engines; a detailed description of parts is given. (*b*) A small catalogue of plain slide-valve steam engines, with drawings of parts. (*c*) Catalogue of stationary tubular boilers, with diagrams of settings.

SULLIVAN MACHINERY CO., Chicago, Ill.—Pamphlet illustrating a line of Bullock diamond drills, together with lists of users and parts.

MERRITT & CO., Philadelphia, Pa.—Brochure in two colors showing expanded-metal lockers for shop and factory use.

NEW BRITAIN MACHINE CO., New Britain, Conn.—A folder representing a line of tool racks, lathe pans, etc., with illustrations of their application.

GARTON-DANIELS CO., Keokuk, Iowa.—A brochure describing briefly the Garton lightning arrester.

A. LESCHEN & SON'S ROPE CO., St. Louis, Mo.—A convenient set of three blotters with a celluloid leaf showing a Leschen ropeway in operation.

A. H. BARBER MFG. CO., Chicago, Ill.—A very attractive catalogue illustrating a large line of ice machines of small capacity for hotels, restaurants, breweries, hospitals, creameries, markets, etc. Many views of recent installations are given.

BAUSH MACHINE TOOL CO., Springfield, Mass.—(*a*) A handsomely printed catalogue in old style, showing an extensive line of radial drills, together with detailed specifications of the machines. (*b*) Similar booklet showing vertical boring and turning mills. (*c*) Pamphlet illustrating several patterns of multiple-spindle drills.

BROWN HOISTING MACHINERY CO., Cleveland, Ohio.—A 250-page bound catalogue illustrating many installations of cranes for a great variety of duties.

ROCKWELL ENGINEERING CO., New York, N. Y.—An argument for fuel oil firing under boilers, with illustations of the Rockwell fuel oil pumping system and fuel oil burner, together with diagrams of applications to various types of boilers.

NATIONAL AUTOMATIC WATER MOTOR CO.—A folder in colors showing the Cassel self-governing, impulse water wheel. The prin-

ciple employed is that of centrifugal force as the basis of automatic mechanism acting in moving the buckets of the wheel out of the line of impact.

SYDNEY F. REYNOLDS, Torrey, Pa.—An attractive card hanger enumerating the special lines of engineering practice pursued by Mr. Reynolds.

ELECTRIC STORAGE BATTERY Co., Philadelphia, Pa.—A quarto pamphlet illustrating and describing in brief various applications of the "Chloride Accumulator" or storage battery to electric lighting and power.

EASTERN MACHINERY Co., New Haven, Conn.—A business-like catalogue and price-list of improved friction clutches, clutch pulleys, and friction cut-off couplings, together with a private telegraphic cipher code.

WESTINGHOUSE ELECTRIC & MFG. Co., Pittsburg, Pa.—Circular No. 1048 showing the Westinghouse No. 68 railway motor.

JEFFREY MFG. Co., Columbus, Ohio.—Circular No. 61, a general description, giving many views of elevating and conveying machinery for mills and factories, mines and industrial power plants.

JOS. DIXON CRUCIBLE Co.—A general catalogue of the extensive line of graphite products of this company.

FRASER & CHALMERS, Chicago, Ill.—The tenth edition of catalogue No. 4 of more than 300 pages, showing a very extensive line of gold and silver mills.

CHAS. A. SCHIEREN & Co., New York, N. Y.—A series of six very handsome blotters showing the varieties of belting manufactured by this company.

AMERICAN BLOWER Co., Detroit, Mich.—A pocket-size catalogue in colors showing a full line of mechanical draft apparatus.

HOLYOKE MACHINE Co., Holyoke, Mass.—A booklet in colors, being illustrations, without descriptions, of calendars for paper and card board.

RIKER MOTOR VEHICLE Co., Elizabethport, N. J.—A descriptive catalogue of the Riker automobile for pleasure and business use.

JENKINS BROS., New York, N. Y.—The 1901 catalogue of an extensive line of steam valves, injectors, and packing.

ELECTRIC VEHICLE Co., New York, N. Y.—Reprint of an article from *The World's Work* entitled "The Electric Automobile a Symbol of Progress." Illustrations of electric vehicles are shown.

B. F. STURTEVANT Co., Boston, Mass.—Bulletin No. 42 entitled "Thirty Days After," illustrating the effect of a recent fire in the works of the B. F. Sturtevant Co. and the progress made in the time mentioned in constructing new buildings.

C. L. BERGER & SONS, Boston, Mass.—A catalogue of engineers' and surveyors' instruments of precision. A great deal of useful information is given for the engineer in the way of formulæ, tables, etc.

WATSON-STILLMAN Co., New York, N. Y.—(*a*) Catalogue No. 59, hydraulic benders, and (*b*) No. 61, hydraulic jacks.

NEW YORK BLOWER Co., Bucyrus, Ohio.—A folder illustrating a heater for use in connection with fan hot blast apparatus.

AMERICAN MACHINERY Co., Grand Rapids, Mich.—A brochure showing in detail the Oliver universal saw bench for pattern shops.

EDWIN HARRINGTON, SON & Co., INC., Philadelphia, Pa.—A 100-page catalogue of a line of machine tools, screw and geared chain hoists and overhead tramway gearing. A telegraphic cipher code is appended.

RAND DRILL Co., New York, N. Y.—A descriptive catalogue of the "Imperial" air compressor.

NARRAGANSETT MACHINE Co., Providence, R. I.—A folder illustrating an extensive line of lockers and wardrobes for machine shop and general factory use.

WARREN WEBSTER & Co., Camden, N. J.—A handsome booklet in two colors, giving facts, figures and results of the economical operation of condensing power plants.

DARLING PUMP & MFG. Co., Ltd., Williamsport, Pa.—Illustrated booklet of the Darling gate valve, with double revolving gate discs, combined equalizing wedges and parallel seats.

NEW HAVEN MFG. Co., New Haven, Conn.—A handy catalogue of engine lathes, planers, slotters, drilling and boring machines, friction pulleys, etc.